DOCUMENT RESUME

ED 376 823 IR 055 274

TITLE	The Information Infrastructure: Reaching Society's Goals. A Report of the Information Infrastructure Task Force Committee on Applications and Technology.
INSTITUTION	National Inst. of Standards and Technology, Gaithersburg, MD.
REPORT NO	NIST-S-Pub-868
PUB DATE	Sep 94
NOTE	160p.
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
PUB TYPE	Viewpoints (Opinion/Position Papers, Essays, etc.) (120)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Access to Information; *Computer Mediated Communication; Computer Networks; Copyrights; Criminology; Disabilities; Emergency Programs; Government Role; Humanities; Physical Environment; *Policy Formation; *Public Policy; Social Change; Standards; *Technological Advancement; Traffic Safety; Transportation
IDENTIFIERS	Electronic Libraries; Internet; *National Information Infrastructure; Telecommuting

ABSTRACT

Intended for public comment and discussion, this document is the second volume of papers in which the Information Infrastructure Task Force has attempted to articulate in clear terms, with sufficient detail, how improvements in the National Information Infrastructure (NII) can help meet other social goals. These are not plans to be enacted, but the material with which the citizens and their government may have a structured conversation, a purposeful interaction, and deliberation on the issues raised in the evolution of more capable means of information processing and human communications. Eight papers are presented in this volume: (1) NII: An Investment in People with Disabilities; (2) Supply and Demand of Electric Power and the NII; (3) Improving Transportation: The NII and Intelligent Transportation Systems; (4) Promoting Telecommuting: An Application of the NII; (5) The Effect of NII on Local, State, and Federal Emergency Management; (6) Public Empowerment with Environmental Information; (7) Arts, Humanities, and Culture on the NII; and (8) Public Safety and the NII: Supporting Law Enforcement and Criminal Justice. Six of the papers include references. (BBM)

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The Information Infrastructure: Reaching Society's Goals

Report of the Information Infrastructure Task Force
Committee on Applications and Technology

IR055274

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This paper is intended for public comment and discussion. Your comments can be sent to any of the following addresses:

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THE SECRETARY OF COMMERCE
Washington, D.C. 20230

Dear Colleague:

By working with Americans in many walks of life, the Clinton Administration is developing a broad vision of an advanced information infrastructure. As an interconnection of computer networks, telecommunications services, and applications, the National Information Infrastructure (NII) can make a difference not just in how people work but in how well they live. This document explores some of the benefits and barriers to how people and organizations will use the NII.

Last May, the Administration released "Putting the Information Infrastructure to Work," which explored applications of the NII in several important areas. The report, released as a draft for public comment, has been successful in drawing input from industry, educators, governmental agencies, and the general public.

We are releasing a second group of papers as a draft for public comment. This set of papers examines eight areas in which NII applications can enhance the quality of life. Specifically, they address how an advanced information infrastructure applies to people with disabilities, electrical power, transportation, telecommuting, emergency management, arts and humanities, public safety, and environmental information.

This report was prepared by the Committee on Applications and Technology of the Information Infrastructure Task Force. The Committee is charged with coordinating Administration efforts to:

- develop, demonstrate, and promote applications of information technology in numerous application areas, including, but not limited to, manufacturing, electronic commerce, education, health care, government services, libraries, environmental monitoring, and those addressed in this document; and

- develop and recommend technology strategies and policy to accelerate the implementation of the NII.

We invite you to comment on the papers by responding to the questions they pose and raising other issues relevant to the application areas. Your response will illuminate and guide government policies and investments to accelerate NII applications.

We look forward to hearing from you.

Sincerely,

Ronald H. Brown

NIST Special Publication 868

The Information Infrastructure: Reaching Society's Goals

A Report of the Information Infrastructure Task Force Committee on Applications and Technology

Office of the Director
National Institute of Standards and Technology
Gaithersburg, MD 20899-0001

September 1994

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National Institute of Standards
and Technology
Special Publication 868
Natl. Inst. Stand. Technol.
Spec. Publ. 868
160 pages (Sept. 1994)
CODEN: NSPUE2

U.S. Government Printing Office
Washington: 1994

For sale by the Superintendent
of Documents
U.S. Government Printing Office
Washington, DC 20402

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Acknowledgments

The Information Infrastructure Task Force and the Committee on Applications and Technology would like to thank the following people for their devoted efforts in developing this document.

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David Lytel—National Institute of Standards and Techology

People with Disabilities
Michela Alioto—Office of the Vice President
Susan Brummel—General Services Administration

Electric Power Supply and Demand
Bob Aiken—Department of Energy
John Cavallini—Department of Energy
Frank Olken—Department of Energy

Transportation
Len Long—Department of Transportation
Gary Ritter—Department of Transportation

Telecommuting
Wendell Joice—General Services Administration
Warren Master—General Services Administration

Emergency Management
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Eliot Christian—United States Geological Survey
Pat Garvey—Environmental Protection Agency

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Introduction

DRAFT FOR PUBLIC COMMENT

PART I: Introduction

This document is the second volume of papers in which the Information Infrastructure Task Force has attempted to articulate in clear terms, with sufficient detail, how improvements in the National Information Infrastructure can help us meet other social goals. These are not plans to be enacted, but the material with which the citizens and their elected government may have a structured conversation, a purposeful interaction and deliberation on the issues raised in the evolution of more capable means of information processing and human communications. At the highest levels of rhetoric and abstraction it is not necessary to reconcile opposing values like freedom and equality. But working out the details of how new communications media will be introduced involves some crucial choices on matters that have historically been the intellectual underpinnings of our democratic society: What is the proper balance between individual liberty and the functioning of social and political institutions like governments, businesses, and associations? How may citizens maintain a sphere in which their private actions are revealed to no one, while deriving the benefits of technological systems whose healthy functioning requires that demand and usage be anticipated, measured and controlled? How can we ensure that the chorus of our community includes the voices of everyone?

Our first volume, titled *Putting the Information Infrastructure to Work*, discussed NII applications in the areas of education and lifelong learning, health care, libraries, manufacturing, electronic commerce, environmental monitoring, and government service delivery. The chapters of this volume help define a national vision for how advanced communications and computing technologies can:

- enable Americans with disabilities to achieve full citizenship in our society
- improve the production, consumption, and management of our energy resources
- increase the safety and efficiency of our transportation system
- allow greater flexibility and worker satisfaction through telecommuting
- save lives and property in times of large-scale emergencies and natural disasters
- empower citizen action to maintain a clean environment
- ensure that nonprofit cultural institutions maintain their position on the front lines of popular creativity and expression
- further educate and better inform both citizens and the agencies they rely upon to maintain public safety

We raise these issues in part to render them accessible to the broadest number of Americans. Yet, their identification as public decisions serves another purpose. Some of the benefits of an improved information infrastructure are public goods that, like air and water, must be maintained collectively by the community at large in order that each of us may share them. Much of the evolution of the National Information Infrastructure will be driven by private investment decisions on new network capabilities or individual consumer spending decisions on new

access devices people may want to buy. But there are also crucial components to an infrastructure that we can only establish and maintain as a community, not merely as a collection of individuals.

PART II: Issues Common to all of the Application Papers

Not surprisingly, many of the same themes that emerged from our first volume of papers continue to be expressed in this volume. However, with a different set of examples some of these themes take on new meaning in their new context.

Equity of Access

The most urgent requirement that these papers express is that no one's ability to be a full citizen in our republic can be lessened by technological change. Equity of access here is broadened in two ways. It includes not just fully abled citizens but also Americans who are experiencing either temporary or permanent loss of one of their senses or who are mobility impaired. Almost a fifth of the U.S. population is disabled in some way, and that number will increase as the number of older Americans increases. America cannot afford to marginalize the contribution these citizens have to make to our collective enterprise. How can the NII be used to compensate for, rather than exacerbate, the gap between the abled and the disabled, so that one's standing as a citizen is not affected by the strength of one's eyes or ears or legs? Equity of access also means inclusion of America's thriving and vibrant private associations alongside profit-making organizations and public institutions. While we often organize ourselves in groups to engage in profit-making activities, much of what we do is through our associations and voluntary activities. This is especially true in the area of arts and culture, and will have a great impact upon the content available with an improved NII. An improved NII must enhance the ability of many people to engage in creative endeavors: to be writers, artists, performers, and historians. How can we ensure that the ability to express ourselves is not limited only to the small portion of the population who are able to earn their living as artists and performers? What actions must we take to extend the capacity for expression?

Technologically Robust Architecture

All of the papers here contribute to a broadened understanding of what the NII can be. These papers go well beyond the narrow conception of the NII as a means by which people can have more choices of what to watch on television. A more intelligent management of our energy resources, for example, could be enhanced if the information infrastructure allowed energy production and storage to be decentralized. The onboard display of vehicle location in conjunction with current road conditions could reduce the amount of time people spend in transit. And remote work locations could reduce the distance they have to travel as well. None of these application areas will be able to develop if we build a specialized infrastructure whose exclusive purpose is to deliver more entertainment on television. They require full connectivity at many different points on the network, and interoperability between networks and services. What is the most thoughtful implementation, especially of the emerging wireless communications infrastructure, that can facilitate these public purposes? How can we ensure that capabilities that can improve the quality of our lives evolve along with the sorts of services that offer more immediate, short term commercial reward?

Diversity of Content

Just as no technology or social strata of our society should be able to dominate what is pictured here as a shared, common set of capabilities for information processing and communication, no one part of our society should have exclusive control over what gets communicated. A system designed exclusively around the dynamics of commercial exchange risks leaving out significant parts of our cultural heritage, producing a society in which we had bookstores in which to buy but no libraries from which to borrow. How can the creation and dissemination of messages be as widespread as their receipt and consumption? How can we

ensure that the richness of the message content is as diverse as our population?

Safety in our Homes and Protection of our Neighborhoods

More than ever, citizens are aware of the work of the public officials who run the criminal justice and transportation systems on our behalf. The NII can facilitate community-based policing and other means by which the concerns of the professionals who serve us may be shared with the citizenry at large. How can we partially recover the long-lost protection against aggression that small towns and word-of-mouth once offered? How can the disparate community of agencies who must respond to emergencies and disasters best coordinate their efforts and solicit our energies? Citizens, armed with information, are also becoming a very potent ally of the agencies charged with environmental protection. Their ability to monitor and call attention to pollution greatly strengthens the fight against environmental degradation. How can we harness environmental consciousness so that people know how to act to protect their homes and communities?

Citizen Control over Private Information

Citizen control over private information is essential if the benefits of an improved NII are to outweigh the costs. If people fear that traffic or energy control systems will be misused as tools of surveillance then they will never be implemented and the efficiencies they offer never realized. And yet, there are cases in which the authorized release of government-held private information can be of tremendous benefit to the citizens concerned, as when a disaster has left them without a home or the ownership records it contained. The information contained in police records is also highly sensitive. How can we be sure that careful auditing of those with access to these systems and the information they authorize for release accompanies widespread implementation of distributed information systems?

PART III: Conclusions

A successful consultation between citizens and their public officials requires not just the accurate expression of the problems to be solved, but the solicitation of advice on solutions, and active listening to the responses. We hope that this document is widely read by people concerned about these specific areas of public policy and with the improvement of the National Information Infrastructure, as well as those concerned more broadly with our historic committment to democratic values. We believe that widespread access to advanced communications technologies can be as enlightening as was the arrival of the electric light, and as empowering as the nation's vast and meticulously maintained power grid. But as technologies they are merely facilitative. Only the application of these technologies as tools for solving social problems can translate technological innovation into social evolution.

People with Disabilities and NII: Breaking Down Barriers, Building Choice

DRAFT FOR PUBLIC COMMENT

In a competitive global economy, our country does not have a single person to waste — opportunity must be open to everyone... I believe our entire nation will share in the economic and social benefits that will result from full participation of Americans with disabilities in our society.

- President Clinton, 12/1/92

PART I: What Is the Application Arena?

On September 15, 1993, the Administration issued "The National Information Infrastructure(NII): Agenda for Action," which formalized several federal NII policy development mechanisms and enumerated the guiding principles and goals for future policy development. A portion of the vision is as follows:

A major objective in developing the NII will be to extend the Universal Service concept to the information needs of fundamental fairness, this nation cannot accept a division of our people among telecommunications or information "haves" and "have-nots". The Administration is committed to developing a broad, modern concept of Universal Service — one that would emphasize giving all Americans who desire it easy, affordable access to advanced communications and information services, regardless of income, disability, or location.

The National Information Infrastructure: Agenda for Action addresses responsiveness to the usage requirements of people with disabilities as a founding principle. Providing choices in the modes of information representation and manipulation will break down existing barriers and accelerate progress toward the full participation of people with disabilities in society as envisioned by the Americans with Disabilities Act (ADA). The technologies that deliver for the NII will be the technologies that LEAD the way in Liberating Expressiveness, Amplifying Dignity for all Americans.

LEAD by Design: Breaking Down Barriers, Building Choice

Ensuring that the NII accommodates the rights of the 49 million Americans with disabilities to equitable communication and information access amplifies innovations and economic returns from national investment in the NII. Existing Federal, State, and local investment activities underway are demonstrating that accommodating people with disabilities is finally gaining recognition as a driving force for advances in human and organizational performance. As this investment strategy gains momentum, information technology developers are weighing in on the broad-based, competitive advantages of this universal design approach, that readily accommodates individual needs associated not only with disability, but also worker re-training, aging, illiteracy, and high performance, critical mission information environments. Adoption of universal design will stimulate the deployment of applications that all consumers will value for convenience, customer choice, and equal opportunity.

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Americans with disabilities represent a large customer base already discussing with industry and government how they envision the information infrastructure will work for them. Most important is customer choice. Until now, choice of the mode or form in which information is represented or communications conducted has not been available. Due to this inflexibility, many people with limitations of hearing, vision, or information processing have been inconvenienced by, or excluded from using these single modality services. Newspapers and documents available in a visual mode only, excluded or inconvenienced customers who were blind until the choices of auditory or Braille modes became available. Auditory-mode-only telephones excluded deaf individuals until multi-modality telephone services were developed that today incorporate hearing relay operators who convert communications between users of auditory-only devices and visual-only devices.

If future telephones or information appliances accommodated the choice of either visual mode (typing) or auditory mode (speaking), direct communications could be achieved and communicating parties would no longer be handicapped by single-modality services that are not compatible. Greatly anticipated as well are visual communications appliances that accommodate a range of needs from sign language transmission to handwritten note-sharing as an alternative to auditory mode only for conversations.

As the NII takes shape, being in the minority in terms of information mode requirements, due to a disability, need not be a significant handicapping condition, if a useful alternative mode is available. People who flexibly accommodate to either auditory or visual modes of information transmission, frequently fail to realize how single-modality services hamper and inconvenience access by people who are unable, due to a sensory mode limitation, to also alternate between both modes.

Many people who can accommodate either visually presented information or auditorially presented information, but not both, due to hearing or vision loss, are now high demand users of on-line services that readily accommodate their choice of mode(s) and media, including visual display (standard or magnified), Braille display, or machine-generated speech. This pattern of early and sustained demand by people with disabilities can enhance the evolution of NII services. It will ensure that the full range of information mode choices unavailable in the past, can now be provided to enhance learning and communications by individuals and organizations.

Historical and Current Evidence of the Benefits

Two of the world's most valuable information technologies, the typewriter and the telephone, emerged from early efforts to accommodate greater choice in information mode by people whose disabilities made them less adaptable to mode differences. The typewriter was invented as a private writing device for a blind member of a royal family. Other developers of early typewriters also designed for blind people. Modality choice of writing device was critical to these early users. Realization of commercial advantages and transfer of this technology to business came much later.

When Alexander Graham Bell invented the telephone, he was attempting to convert speech to a visual representation in order to accommodate a greater choice of information modalities for his wife who had a hearing loss. Unfortunately Bell's invention failed to accommodate conversion of information from auditory to visual mode as intended. Instead the telephone extended the range of the auditory mode and broke down distance as a barrier to spoken communication. The originally intended benefits to deaf people have been late and inadequate. Only in the last 30 years has a usable choice for telephone access by deaf people become available. At that time, deaf people began purchasing and adapting old Western Union teletypewriters (TTYs) that only enabled communications with other TTY users. Communications between TTY users and standard telephone users has only become widely available in the last 2 years due to the establishment of ADA mandated state relay services.

Like the typewriter, transfer and extension of text messaging took a long time and could have taken even longer. One of the lead engineers of the originial Advanced Research Projects Agency Network (ARPANET), the predecessor of Internet, was very accustomed to modality choice because he used a text messaging device (TTY) when communicating with his wife by telephone due to her hearing loss. This exposure positively influenced the inclusion of text messaging as an ARPANET application even though it was not part of the orginial planning. Today the value of this electronic text messaging or e-mail capability to people around the world is beyond estimation and choice of information mode is becoming an inherent feature in well-designed information applications.

Another contemporary ARPA example of choice driving innovation is infrared-based eye-tracking. This technology has been matured and commercialized by a small business, that targeted individuals with severe disabilities as the first customers of this hands-independent and body-movement-independent intelligent interface device. Today, this eye-tracking product is being sold around the world to a small, but growing number of people with extensive mobility limitations for whom keyboard use is not an option.

This product, after being commercialized and matured by users who demanded high performance and reliability, is now being purchased by federal and private sector laboratories. Oak Ridge Laboratories is exploring its use to control tele-robotic vehicles in hazardous environments. A number of usability laboratories world-wide have purchased a related product that enables user performance measures to drive advanced designs of visual interfaces. A head-mounted display incorporating eye-tracking is next; it will accommodate not only people with disabilities but anyone in high demand, high performance environments, including national security.

Speech recognition, a technology increasing in power and potential, also originated through ARPA resources. Quadriplegic individuals have become recognized by the speech recognition industry for the significant contributions they've made to maturing a technology that is likely to revolutionize human-computer interactions in the near future. These pioneer users, without functional use of a keyboard, were driven not by device novelty, but by true performance demands and the need for choice of information input mode that accommodated effective interactions with a computer. Other user groups who have begun to derive significant benefits from speech recognition are people with learning disabilities and people whose repetitive strain injuries preclude continued use of a keyboard.

Another powerful telecommunications advance was spearheaded recently by a person with a profound hearing loss who worked with an engineer to overcome her dependence on text telecommunications. She wanted another choice. The resultant product is elegant in its simplicity and cost effectiveness. With this product, she is able to use both standard and cellular phones directly. All amplification is provided by her existing hearing aid. While the cost-per-unit is approximately $80, there are immense long-term benefits and value of this technology to a segment of the hearing impaired population around the world.

Federal Evidence of Benefits

The General Services Administration, Clearinghouse on Computer Accommodation (COCA), has been tracking these little-known innovation synergies for a number of years. Through the Congressionally chartered Federal Laboratory Consortium for Technology Transfer, COCA has recently begun serious discussion with the Army Research Laboratory and other labs that exhibit strong interest in user interfaces that accommodate choice.

COCA became aware of this innovation dimension during the past decade while assisting federal agencies in identifying and shaping their investments in technology to fully accommodate people with disabilities. Public Law 102-569, Section 508, (1992 Amendments to the Rehabilitation Act of 1973) is the source of this Federal policy.

As implementation of federal accessibility statutes proceeds, federal agencies are discovering that purchasing information systems that accommodate a wide range of user interface requirements promotes productivity and ensures access to work-related and public information by people with disabilities. Organizations are benefiting from the ability to recruit and retain quality employees and the ability to effectively interact with all clients, including those with disabilities.

Agency experiences with user interface options that incorporate maturing technologies such as speech synthesis, speech recognition, or infra-red technologies also provide an effective means for evaluating near-term applications with potential benefit to all users. Many employees in "hands-busy," "eyes-busy," or noisy environments can benefit today from flexible interface alternatives that have already been adopted by people with disabilities.

Applications with user interfaces that accommodate choice of alternative displays and keyboards are also being employed to minimize or prevent the visual fatigue and repetitive strain injuries associated with keyboard-intensive environments. As the work-force ages, accessible information services must support the requirements of people who develop age-related limitations of vision, hearing, or mobility. As planning by the Federal Government increasingly addresses a comprehensive information infrastructure, planning for choice represents a solid foundation to maximize the value of information applications and acceptance by users.

LEAD by Design as an NII Innovation Driver

As awareness of disability-driven innovations becomes recognized, and societal dependence on technology for community participation and economic growth continues, breaking down barriers and building choices will become recognized as an innovation driver globally. E.H. Sibley summarizes this strategic opportunity:

"In reflecting on the problems of the multiple language and character sets faced by the world, it appears that a large portion of the potential computer user population is at a disadvantage. They must use difficult interfaces or learn another language. When we add up the cost of not having good input/output devices for the many people who can compute but find it cumbersome, we can conclude that the cost of efficient new devices would pay for themselves many times over. Particularly at a time when the world's political barriers are being removed, perhaps our new opportunity frontier should be to remove the barriers to computing for all humanity, be they different in language, representation, or device needs."[1]

The recent report on High Performance Computing and Communications: Toward a National Information Infrastructure by the Office of Science and Technology Policy also acknowledges this opportunity. Addressing intelligent user interfaces, the report states, "A large collection of advanced human/machine interfaces must be developed in order to satisfy the vast range of preferences, abilities, and disabilities that affect how users interact with the NII."

The NII affords a unique opportunity in the design of human interface technologies to formalize collaborations among early demand user groups with a wide range of preferences, abilities and disabilities in order to reduce the lag time between technology transfer and user acceptance.

The Electronic Industries Foundation has reported that "manufacturers who have found ways to simplify the user interface have seen positive consumer response in terms of increased sales and decreased product returns... A growing body of research suggests that there are ways to design products that can accommodate functional limitations, and actually enhance their ease of use for everyone." [2]

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[1] E.H. Sibley, Communication of the ACM, May 1990

[2] EIA Seal of Accessibility Development Plan Version 1.0 9/17/93

The use of generic performance benchmarks such as those developed by Pirkl and Babic (1988) would stimulate the design needed to ensure customer choice. The benchmarks include:

- cross-sensory redundant cuing, feedback, and modes of operation that supports choice
- reduced complexity of operations
- adjustable product/user interfaces designed for a variety of populations and accommodation levels
- designing beyond basic needs in a manner that enhances user's independence, self-respect, and quality of life.

These findings are congruent with the growing recognition that technological advance only provides a competitive advantage for a short time; superior design and manufacturing — doing it right for the customer and quickly the first time ensures true economic advantage in a customer driven, global economy.

What is the Public Interest in Investing in NII and People with Disabilities?

This section outlines how significant benefits are anticipated in at least five areas. The public will be particularly interested in how building choice in NII:

- removes communications and information access barriers that restrict business and social interactions between people with and without disabilities
- removes age-related barriers to participation in society
- reduces language and literacy-related barriers to society
- reduces risk of information worker injuries and
- enhances global commerce opportunities

Removes Communications and Information Access Barriers that Restrict Interactions Between People with and without Disabilities

An individual with limited mobility may not have easy access to public libraries, places of employment or business, or retail outlets. Although these facilities may be "accessible" for the wheelchair user, getting to and from such locations often poses a serious challenge. Loss of hearing or sight are obvious barriers to information access.

The capacity to communicate with, and collect information from almost any point on the globe from one's home has already expanded the ability of persons with disabilities to participate in an information oriented society more effectively than ever before.

Federal policy promoting the coordination of a NII holds great promise of protecting the gains already made in information access by persons with disabilities. However, if the design and development of the NII does not accommodate the technical requirements for choice needed to provide universal access, then information utilization by persons with a variety of disabilities will be set back to the days before the development of computers.

At present, even without the development of a coordinated infrastructure, people with disabilities are carrying out electronic banking, shopping on-line, telecommuting, providing information services to others, all from their homes. In the office setting via electronic document processing, visually impaired and blind employees have access to vital information equal in some cases to their sighted colleagues. The economic impact of developing an information system that fails to accommodate the choice of modes of operation including access devices that convert electronic information into a form that can be used by a person with a disability (i.e., Braille displays, speech synthesizers, or voice input processors) will be far greater than the cost of ensuring this

universal access in the infrastructure from its inception.

Personal Experiences of How the NII is Reducing Barriers

"There are many truths of which the full meaning cannot be realized until personal experience has been brought home. "

John Stuart Mill 1800-1873

What follows is a list of personal experiences that offer insight into how the NII can benefit citizens with disabilities.

- Reduced Barriers to Full Participation in Society

I am a C7 quadriplegic who has completed a course in desktop publishing. I have been disabled for two years and very eager to get back into the work force. I have learned I'm still employable regardless of my disability. I recently learned about telecommunications and the different networks for communicating. With electronic mail I communicate with various people from all around the world. My life has really opened up with my career change and the electronic information systems.

- Reduced Barriers to Business and Employment

I am a C5 quadriplegic living in the Silicon Valley and a current intern with the Networking and Communication Department. I have been disabled for ten years from a motor vehicle accident in 1983.

I use computer telecommunications daily in numerous different functions.
Telecommunications has opened up a new world, allowing me to communicate via e-mail with colleges, government agencies, and organizations. The future success of telecommunications is phenomenal, especially for the disabled community. It not only allows a person unable to go out into the community to access endless amounts of information, but also permits disabled persons, such as myself, to eventually return to the workforce (via telecommuting) and become productive citizens again.

I have a dream of some day starting a nationwide bulletin board for attendant care for the disabled community. It would be an attendant registry that would permit disabled persons to hire attendants anywhere in the United States and find qualified and compatible employees.

- Reduced Communication Barriers

I am 17 years old. I am an oral, profoundly hearing-impaired student who is fully mainstreamed in the 12th grade at the Park School in Baltimore, MD. I did not really have access to e-mail until early October, when a friend of mine proposed that we e-mail each other...e-mail turned out to be easier than I thought, and it has been wonderful because it has enabled me to communicate with my friends from around the Atlantic Seaboard region.

The "electronic super-highway" is a boon for deaf/hearing impaired people because it enables them to communicate via the written word, which is a very effective alternate means of obtaining vital information in a relatively short period of time. It is my hope that the White House will make access to the information highway universal.

Thank you for allowing me to voice my concern regarding this matter. E-mail is such a wonderful thing and I am fortunate to be living in an age where communication opportunities (especially for the deaf/hearing impaired) are expanding.

- Reduced Information Access Barriers

I am using e-mail every day on campus at Gallaudet University, and because of my social shyness, it is much easier for me to socialize on the keyboard. I also find it great for research, and am doing my best to learn about Internet services as quickly as possible. I have been hard of hearing since birth, 50db equilaterally.

- Reduced Barriers to the "Basics" in an Information Society

Rodney, a senior at Rogers High School, Puyallup, Washington, has no use of his arms or legs and uses a mouth wand to operate a computer. He began using a computer at age 6, and learned to read and write in this manner.

When asked a question, Rodney balances his wand on a box strategically placed near his terminal. A computer he says "is sort of like running water. You don't know what you'd do without it."

- Removes Age-related Barriers to Participation in Society

According to the U.S. Bureau of the Census, by the year 2000, the U.S. population of those over 65 years will be greater than 34 million, this figure world wide will be over 419 million. The Bureau projects that in the next 50 years, the U.S. population will increase overall by 19.8 percent; however, the population of those 65 years or older will increase by 117 percent, more than doubling from 31.6 million to 68.5 million. By designing the NII to meet the needs of people with disabilities, the NII will also have the flexibility and competitive advantage of accommodating the freedom of choice and independence desired by this unprecedented number of older people. A well-designed NII that accommodates a wider range of vision, hearing, and mobility differences will normalize and not stigmatize our aging society. Personal and economic loss associated with past age-discriminatory designs can be minimized.

The NII will increasingly be a key factor in the independence, productivity, commerce, and community participation of a significant percentage of older people in our society. User acceptance will be accelerated by designs that make the NII easier and simpler to use. Those over the age of 50 control over 50 percent of America's discretionary spending funds (Ostroff 1989), and those over 65 control 77 percent of all assets (Pirkl and Babic 1988).

Reduces Language and Literacy Related Barriers to Society

Full implementation of the Television Decoder Circuitry Act of 1990 will ensure not only full access to broadcasting by deaf Americans, but will also provide the choice of text captioning that may serve as a powerful application to reduce illiteracy in this country. According to the most comprehensive literacy study ever done by the U.S. government, the literacy levels of 90 million people in the United States is deficient.[3] This situation represents a direct threat to the U.S. economy. Another significant benefit of television with text captioning will be its usefulness as an effective learning technique for people who are learning English as a second language.

Reduces Risk of Information Worker Injuries

With 70 million personal computers in use, strain injuries have skyrocketed. The U.S. Department of Labor figures show repetitive stress injuries represent 60 percent of all job-related illnesses. Estimates of the annual cost to business is $20 billion.[4] Pilot demonstrations of speech recognition for all workers are underway in several large companies as a strategy to increase productivity and decrease keystrokes. Again, pioneer users of this technology have been people with disabilities who needed a choice other than a standard keyboard. NII applications must interoperate with intelligent user interfaces accommodating a wide range of user needs and preferences such as speech interfaces.

Enhances Global Commerce Opportunities

There are approximately 750 million people with disabilities in the world. Meeting the needs of

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[3] U.S. Department of Education, National Center for Education Statistics, National Adult Literacy Survey, funded by Federal and State Governments

[4] Smithsonian, June 1994

people with disabilities in the NII will provide U.S. companies an early competitive advantage in the global marketplace.

The global advantages of the increasing U.S. market responsiveness to people with disabilities was noted in the 1993 report of the Commission of the European Communities. The report, European Technology Initiative for Disabled and Elderly People - Call for Proposals, states as follows:

"Technology transfer from the major European Information Technology industry to the Small and Medium-sized Enterprises, with the knowledge of the customer, will be critical to the competitiveness of the European Rehabilitation Technology industry. This technology transfer opens new markets for European technology. It also helps counter the threat posed to European industry by US legislation in favor of people with disabilities which is both forcing the Information Technology industry to take their needs into account and stimulating a strong rehabilitation technology industry in the US."

Deploying technologies such as real-time captioning, originally developed to accommodate deaf individuals could also enhance international commerce activities. For example, U.S. economists working on General Agreement on Tariffs and Trade (GATT) spent many hours transcribing and comparing notes from working sessions before strategizing on next steps. Delegates with limited English proficiency may experience even greater difficulties processing meeting content when it is only presented in spoken English. This situation may tend to increase misunderstanding and decrease trust, resulting in costly negotiation delays. Deploying real-time captioning would provide all delegates with a written English transcript of the proceedings at the end of the meeting. The captioning equipment would also provide to the entire group a real-time text display of the speaker's words that would serve to enhance language comprehension by delegates with limited English proficiency.

The technical solutions employed today to magnify text displays for low vision users are identical to solutions being evaluated in Saudi Arabia to make English software applications readily translatable to Arabic. This approach can be applied to any foreign language and may reduce barriers to market entry for U.S. software developers.

PART II: Where are We Now?

This section addresses the emerging consensus on universal design and convergence of policy and design practices in both the public sector (Federal, State, foreign governments) and the private sector that are becoming examples and support mechanisms for NII applications to break down barriers by building in customer choice.

National Laws and Policies

Since 1988, statutory requirements for federal agencies have been in place to ensure that agency investments in information technology integrate requirements to meet the needs of people with disabilities are met. This policy is based on two laws, Public Law 100-542 and Public Law 102-569. Public Law 102-569, Section 508 addresses the requirement that Federal investments in information technology be conducted in a manner that ensures access to computer and telecommunications products and services by employees with disabilities and citizens with disabilities accessing public information services. Public Law 100-542, the Telecommunications Accessibility Enhancement Act, mandates a proactive approach within the government to advancing accessibility to the Federal telecommunications system by individuals with hearing or speech limitations.

These laws do not represent a radical new direction for federal agencies, but serve to reinforce existing mission requirements under the Rehabilitation Act of 1973. This Act requires federally conducted or federally sponsored programs to be accessible to persons with disabilities and mandates that management policies must not discriminate in the hiring, placement, and advancement of persons with disabilities.

The Americans with Disabilities Act of 1990 (ADA) has adapted and extended many of the existing responsibilities of the Rehabilitation Act of 1973 for implementation outside the Federal Government. The law requires barrier-free access to places that serve the public, such as theaters, restaurants, and museums. State and local government services, transportation, and telecommunications services must also be accessible. Discrimination on the basis of disability in private sector employment is also prohibited.

Protecting the rights of access to the evolving information infrastructure by customers with disabilities is a national responsibility as a result of the Americans with Disabilities Act. As implementation of ADA continues, accessibility to the information infrastructure represents an important area for Federal, State and private sector sponsored pilot demonstrations to conduct performance benchmarks and showcase early benefits and successful implementation strategies.

Efforts of Federal Agencies

General Services Administration, Council on Accessible Technology

In 1984, GSA created an interagency committee that is now called the Council on Accessible Technology. The Council, comprised of senior executives from 30 agencies, promotes the planning and investment in information infrastructure that demonstrates the flexibility of choice needed to accommodate people with disabilities.

The Council advances the business practice of including persons with disabilities in the design, pilots, and early implementation of all new government information infrastructure investments.

Last Fall, the Council co-hosted with the Department of Commerce a seminar entitled "Universal Design: Accommodating Diversity and High Performance." The seminar was attended by approximately 200 people from Federal and State Governments and industry. The seminar took place in conjunction with the Department of Commerce' Sixth Annual Accessible Computer Technology (ACT) Exhibit.

At the Department of Commerce's Seventh Annual ACT Exhibit, on Oct. 5/6, 1994, the Council, together with the Committee on Application and Technology, will be showcasing Federal, State, and private pilot demonstrations of applications that exemplify how the needs of people with disabilities can be met in the NII. The Clearinghouse on Computer Accommodation will assist in pre-selection of applications that meet existing accessibility guidelines.

The Council will conduct a similar showcase of NII applications that are usable by people with disabilities at Interchange ' 94, October 12/13, 1994.

General Services Administration (GSA) Clearinghouse on Computer Accommodation (COCA)

Since 1984, the GSA Clearinghouse on Computer Accommodation (COCA) has served as a model demonstration center for advancing accessible information environments, services, and management practices in order to stimulate the governmentwide capacity-building needed to meet statutory requirements. The center provides technical consultation, presentations, training, and assistance to federal agencies. The center also serves as a pilot demonstration site and market need/market utilization conduit between federal agencies and laboratories, universities and industry.

COCA facilitates a network of Federal employees with disabilities and their support personnel that provides early customer feedback on new service delivery technologies and practices. Coordinating with COCA and this network, the Computer/Telecommunications Accessibility Resource Exchange (CARE), is now a part of many agency programs. CARE members piloted with GSA developers, the first accessible information kiosk. GSA continues to advise and provide accessible kiosk services to customer agencies.

Current projects underway include:

- working with Government Printing Office, National Institute of Standards and Technology, and Internal Revenue Service to ensure development of electronic document services that are accessible
- providing guidance on developing accessible CD-ROMs
- developing a tutorial to assist blind users becoming oriented to Windows
- preparing a COCA handbook as a model for universal access in electronic document preparation
- evaluating Internet browsers, including Mosaic and Lynx to enhance the access modes supported

Last summer, COCA piloted a program that exposed future human interface designers to the government's need for an accessible information infrastructure. Stanford University participated in the program and inquiries for future participation were received from the Georgia Institute of Technology and the Kennedy School of Government at Harvard University.

Due to changing research priorities, Federal laboratories committed to dual-use technology and high performance technology are also beginning to approach COCA to discuss collaborative efforts. In this manner, market demand will be stimulated for alternative modes of computer interaction needed by persons with disabilities. The synergistic goals of dual-use technology and accommodation of diversity can be achieved. It is anticipated that this technology push initiative will be complemented by a market pull within the labs for user interfaces offering greater flexibility to accommodate a wider range of abilities, disabilities and preferences.

Microcomputer Training Program for Persons with Disabilities (MTPPD)

(MTPPD) serves persons with disabilities within and outside the Department. MTPPD also supports the Department's Nationwide Office Automation for the VA (NOAVA) implementation to ensure employees with disabilities receive equal access to NOAVA OA systems and platforms.

The MTPPD program provides training to employees within the VA and from other federal agencies. The cost-reimbursable training addresses both adaptive technology and common application packages. Other program services include consultations, tours, equipment demonstrations, and product evaluations. Document scanning and converting services, including brailling, are available to agencies on a cost-reimbursable basis.

Department of Commerce (DoC) Committee on Resources for Electronic Accessible Technology to End Users (CREATE)

CREATE is the vehicle responsible for planning and coordinating Department-wide activities in increase awareness of accessible technology issues and explore ways to ensure that the information environment is usable by people with disabilities. CREATE hosts the Accessible Computer Technology Exhibit hosted annually in October to increase awareness and effective use of commercially available products and services that accommodate people with disabilities.

Department of Agriculture (USDA) Technology Accessible Resources Gives Employment Today (TARGET) Center

The Accessible Technology Program has established the TARGET Center to support USDA employees nationwide and other federal agencies. TARGET provides evaluations,

demonstrations, resource information, needs assessments, and training on accessible technology. The center uses open systems concepts to highlight accommodation solutions available on personal computers. TARGET demonstrates how accessible technology optimizes productivity and job retention of career employees by reducing worker compensation costs and disability retirements from end-user computer injuries.

Department of Defense Computer/Electronic Accommodations Program (CAP)

The CAP Office assists DoD activities to procure adaptive equipment which provides access to computer systems and telecommunications as required by Public Laws 102-569 and 100-542. The CAP Office provides technical, educational and financial support to assist employees, supervisors and managers identify and procure appropriate accommodations. The CAP Office conducts special projects to assist DoD activities to ensure an accessible work place. Projects include working with DoD components to ensure that training centers, libraries, and programs are accessible; and coordinating with system acquisition activities to ensure that accessibility is considered in the procurement of DoD systems. CAP also established the Technology Evaluation Center (CAPTEC), a facility dedicated to the evaluation and testing of emerging technology. The CAPTEC assists DoD supervisors and employees in choosing appropriate adaptive equipment for creating work environments that are accessible to persons with disabilities.

Internal Revenue Service Computer/Telecommunications Accessibility Program (CAP)

The Computer/Telecommunications Accessibility Program (CAP) was established to ensure the IRS makes electronic information accessible to people with disabilities. CAP assists the managers and employees in selection and procurement of appropriate adaptive technology. The CAP office works with acquisitions and procurement personnel to ensure that accessibility is included in information technology procurements. CAP has a demonstration center with adaptive equipment.

National Security Agency Center for Computer Assistive Technology (CCAT)

The National Security Agency's CCAT provides demonstration of assistive technology devices and professional resources for agency employees with hearing visual or physical limitations. The goal of the center is to provide assistance and identify alternative solutions for persons with disabilities.

Federally Sponsored Activities

Department of Education (DoEd) National Institute on Disability and Rehabilitation Research (NIDRR)

- Technology-Related Assistance Act Funded States

In 1994, Congress re-authorized Public Law 100-407, the Technology-Related Assistance For Individuals with Disabilities Act (P.L.103-218). Administration of the law continues to be conducted by the NIDRR. The states have received grants for "systems change" activities to eliminate barriers that impede information and acquisition of assistive technology services and devices through implementation of consumer-responsive systems.

- Project Enable, West Virginia Research & Training Center

Project Enable is a full featured computer bulletin board system providing information on disability, rehabilitation, employment, and education. It is used primarily by people with disabilities and their families, educators, students, and rehabilitation workers who participate in over 150 special interest discussion groups.

- Rehabilitation Engineering Research Center (RERC) on Communications and Information Technology Access, Trace Center, University of Wisconsin, Madison

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The Trace RERC studies access problems of people with disabilities to computer and information systems, and disseminates information on solution strategies. Trace works with computer manufacturers and software producers to outline how existing products can be made more accessible to people with disabilities. Through Trace efforts, disability access features are being built into commonly used operating systems. Current cross-disability goals include working with a broad coalition to:

- identify ways that manufacturers can build access directly into next generation systems to accommodate the widest possible number of customers
- identify strategies to allow customer choice of mode of operation.

National Science Foundation (NSF)

DO*IT (Disabilities, Opportunities, Internet-working, and Technology), University of Washington: DO*IT enables high school students with disabilities to explore careers in science, engineering, and mathematics through "mentorships" conducted via Internet with practicing engineers and scientists from around the world, many of whom also have disabilities.

Selected Non-profit and Academic Activities

Project EASI (Equal Access to Software and Information)

Provides assistance to higher education in developing computer support services for people with disabilities. Project EASI provides information and guidance on campus applications of adaptive computer technology for access to information, instruction, research, and employment. Project EASI's Internet server hosts an active discussion about computer/telecommunications access issues.

WGBH-Caption Center, Boston, MA

WGBH has pioneered advances in accessible programming for more than 20 years since captioning the first nationally broadcast program.

WGBH is working to make all programming accessible to the nation's 24 million deaf and hard-of-hearing viewers. Instrumental in the Television Decoder Circuitry Act of 1990, they also launched Descriptive Video Service (DVS) in the same year. DVS makes television accessible to millions of people who are blind or visually impaired through narrated descriptions of key program elements.

Corporation for Public Broadcasting/WGBH National Center for Accessible Media (NCAM), Boston, MA

NCAM was established in 1993 with funding from the Corporation for Public Broadcasting. NCAM is taking steps to accelerate media access to populations that have been underserved or denied access. Project examples include:

- Closed Caption University — empowering individual public television stations to caption their own programming
- Access Primer and Toolkit — primers for stations interested in technology applications such as captioning, descriptive video, and foreign language (especially Spanish) translations and tips on building relationships with deaf, blind, and minority-language communities
- International Broadcasting — study of how countries around the world are providing access to their TV systems
- Vertical Blanking Interval (VBI) Project is experimenting with using the VBI of the television signal instead of the third audio channel in routing descriptive video or Spanish video
- Print Access Project — to digitize newspapers and deliver them into the home fully accessible to blind, low-vision, and other print-disabled people.

World Institute on Disability (WID)

WID focuses on creation of public policy that will give people with disabilities access to the information age. WIDnet is a network that focuses on disability policy.

Stanford University, Center for the Study of Language and Information (CSLI)
CSLI's Archimedes Project works to improve access to information for individuals with disabilities by influencing the early design stages of emerging technologies. The project:

- applies basic research about information and communications to the design of access for people who are disabled
- educates those who will develop the next generation of technology about the advantages for the whole community of designing general access. In both instances maximum leverage is obtained by emphasizing design rather than retrofit.

Private Sector Activities

Disability Action Committee for Xwindows (DACX)

DACX is working to solve accessibility issues presented by the Xwindows graphical user interface. Membership includes the major Xwindows vendors including DEC, IBM, SUN, and representatives from academia. The purpose of DACX is to develop solutions which will allow users with disabilities to access systems running the Xwindows GUI. The group has succeeded in developing access utilities for users with motor impairments. It is also working on developing necessary "hooks" for screen reading programs. Access-related software developed by DACX is distributed through the Xwindows Consortium.

The International Committee on Accessible Document Design (ICADD)

ICADD promotes standards for producing documentation for "print disabled" individuals. Membership includes representatives from industry, academia, and government from many countries around the world. The purpose of ICADD is to develop and encourage the document transformations that print-disabled persons are working toward. ICADD has succeeded in implementing accessibility in existing International Standards Organization (ISO) standards such as the Standard Generalized Mark-up Language (SGML)

Electronic Industries Association (EIA)

Electronic Industries Association's Consumer Electronics Group and the Electronics Industries Foundation (EIF) are currently working to create a Seal of Accessibility for consumer electronics products.

When completed, the Seal will certify that designated mainstream products can be used by persons with functional limitations associated with aging, a temporary injury, or permanent disability, and that the products meet the accessible design guidelines established by a committee comprising manufacturers, disability experts, consumers, and representatives of organizations serving the needs of people with disabilities. The seal should help manufacturers during the design process and consumers during the selection process.

Industrial Design Excellence Awards (IDEA), Industrial Designers Society of America and *Business Week* Magazine

Promotes recognition of industrial design excellence as a strategic tool for competitiveness in the domestic and global marketplaces. Industrial designers make products easy to use, safe, comfortable, appealing, and ecologically responsible. One of the 18 gold medal winners for 1994 was James Pirkl, designer of a book on *Transgenerational Design: Products for an Aging Population* which highlights the marketplace advantages of well-designed products that also accommodate older people and people with disabilities.

International Activities

There are three major European program efforts underway to accelerate the productive application of technology on behalf of people with disabilities. The largest of the three is Technology Initiative for Disabled and Elderly (TIDE). TIDE is a community research and development initiative in the field of rehabilitation technology designed to stimulate the creation of a single market in Europe. TIDE assists elderly and disabled people to live independently and participate more fully in the social and economic activities of the community.

The main goal of the RACE program (Research and Development on Advanced Communication in Europe) is to develop technology and infrastructure in order to prepare for the introduction of broadband network services and to promote European industry competitiveness in this field.

This activity includes delivery of services to the largest possible cross-section of the user population, including people with disabilities. The project includes development of a standard reference manual of specifications for designers that will provide the necessary knowledge about human factors to ensure network accessibility to all users.

Member States of the European Union recognize the importance of education, employment, and accessibility for people with disabilities. Institutions of the European Union have issued resolutions to promote equality of opportunity and integration of people with disabilities.

Canada's information infrastructure planning has also begun to address integrating the needs of people with disabilities. Canadian representatives have requested information about U.S. plans.

PART III: Where Do We Want To Be?

"Information, which will be education, which will be employment, which will be income, which will be possibility, must flow to all Americans on terms of equal accessibility without regard to physical condition. And we are committed to doing that."

- President Clinton 5/13/94

This section addresses examples of user expectations of important NII capabilities. These capabilities will be needed to address the national goal of equal accessibility in communications, commerce, and community among people with and without disabilities. The examples are grouped under the four functional capability areas identified in the Vision for a 21st Century Information Infrastructure report of the Council on Competitiveness:

1) widely accessible and interoperable communications networks

2) digital libraries, information databases and services

3) information appliances and computing systems

4) trained people to build, maintain, and operate these resources.

This May 1993 report envisions:

The information infrastructure of the 21st Century will enable all Americans to access information and communicate with each other easily, reliably, securely and cost-effectively in any medium — voice, data, image or video — anytime, anywhere.

Widely Accessible and Interoperable Communications Networks

- Expectations of business owners with disabilities will be met for commerce, information, health, and manufacturing networks that offer the visual and auditory redundancy needed to accommodate their choice of modes of communications and information processing in a manner that is also transparent to and convenient to their customers.

- Education networks should accommodate the needs of parents, children, and teachers to have alternative modes of communication and information sharing available to accommodate situations when one or more of the communicating parties has a disability associated with hearing, seeing, or speaking. For example, text messaging might substitute for telephone conversations between a parent and teacher. Multi-media learning applications would support redundancy options allowing student choice of information presented either visually or auditorially/tactile or both.

- Accommodating people with disabilities will be a tangible and widely recognized citizen benchmark for responsive and respectful service. Citizen expectations will be met for equal access and improved services at all levels of government service delivery. For example, 911 emergency service calls will accommodate text telephone users who are deaf or speech impaired.

- Enhanced service/routing features on 800-number arrangements need to accommodate people with disabilities by detecting text telephone users and routing their calls to a data server when voice telephone calls to the same number are routed to a recorded voice response unit. 800 numbers placed to an information service agent would automatically patch to the nearest State relay operator service if the agent failed to respond with a device capable of communicating directly to a text telephone.

- The 800 number service capability should also provide in a similar manner an automatic linkage option to the language translation services industry when needed by a caller or information services agent to complete a communication transaction when a common language is not available to the two parties.

- The large federal investment in Federal laboratories and the technology transfer and dual- use programs should meet citizen's expectations by contributing to advanced communications and information services that are designed to accommodate all user choices of modes of operation. This will be achieved through the Federal Laboratory Consortium and other organizations.

- Expectations by hearing impaired and speech impaired executives that their requirements for real-time captioning through text or sign language inserts will be available in standard video conferencing environments will be met. This capability will also accommodate participants at international conferences who experience language barriers. Blind participants will be able to receive transmitted text by Braille if desired.

- Participants in courtroom proceedings including judges, jurors, and attorneys will be accommodated as requested using the suite of service choices described above to accommodate hearing loss, vision loss, or language differences.

- Wireless voice and data service offerings and equipment will be able to accommodate people with disabilities in a manner that represents a significant improvement from what is commercially available today in terms of interoperability, competitive offerings, and user choice and customization options.

- The access component between the customer premises equipment and the user with a disability will be designed with as much care and attention to flexibility and interoperability as the access component between the customer premises equipment and the transport carrier.

- Expectations from current users with disabilities that uninterrupted choice of access mode to existing network utilities and services will continue as the technologies advance. This currently includes electronic mail (video mail, multimedia mail, etc.), directory service, security service, electronic commerce, and bulletin board systems.

- Expectations that students with auditory or visual limitations will also be able to benefit from the commercially prepared multi-media and "real-time video" capabilities employed for individual and group learning.

- Expectations from community members that electronic town meetings and government provided kiosk services will accommodate full participation by all.

- Expectations from blind people as well as those learning English that descriptive video services would become a standard option. Descriptive video services provide a spoken description that accompanies visual events.

Digital Libraries, Information Data Bases and Services

- Federally funded activities of the High Performance Computing and Communications Program, will address the needs of people with disabilities to use these services and include people with disabilities in their pilot projects. This includes projects such as NSF funded digital libraries research, NASA developed prototype digital libraries, ARPA funded hypermedia systems with intelligent user interfaces and National Institutes of Health developments in medical datebase management.

- Expectations of people who are print-handicapped due to vision problems or have problems handling printed materials due to dexterity limitations will be met. These members of society will be able to access all publicly and commercially available electronic information services using their choice of access modes.

- The Government Printing Office "Access" Act of 1993 will accelerate services that are fully usable by people with disabilities including:

  1) an electronic directory of federal electronic information

  2) on-line access to the *Congressional Record*, the *Federal Register*, and other appropriate publications and

  3) an electronic storage facility for federal electronic information.

- Expectations of retirees for intensive, early, and satisfied use of NII education, commercial, and leisure applications will be closely tied to the ease with which their age-related choices for large print, amplification, and speech-based interfaces are met.

Information Appliances and Computing Systems that are Easy to Use

- Expectation that information appliances or customer premises equipment that used to include only telephones, PCs/workstations, fax machines, optical character scanners, LANs, modems, video equipment, cellular phones, pagers, personal digital assistants, and notebook/laptop computers will now also include braille displays, braille computers, alternative keyboards, captioning systems, closed circuit televisions, CD-ROM drives, text telephones, text-to-speech devices, voice recognition systems, augmentative communication devices, assistive listening devices, and wireless personal communication services.

- Expectation that end-to-end telecommunications service will fully deliver to people with disabilities and include not only transport service, but also equipment and software choices needed for end to end connectivity. These services will offer user preference of modality or combination of modalities in which to present information or communication including:

  1) voice-oriented

  2) data-oriented

  3) video-oriented (including video conferencing)

4) multi-media oriented

5) wireless-based

- Older Americans will not be resistant to change as sometimes predicted if new appliances accommodate age-related vision, hearing, or dexterity limitations through better designed technologies offering greater range and mode options than are available today.

- The capability to accommodate people with disabilities will be recognized as an essential performance measure during selection from among competing appliances. This benchmark will ensure the flexibility of choices needed to access all communications networks and services and also accommodate learning preferences, noisy environments, hands busy environments, and high performance environments, including national security.

- Expectation that executives with disabilities while on travel will be able to secure an equivalent level of access to information and communication services as their non-disabled colleagues through well-designed information services such as kiosks, e-mail, and FAX-on-demand that accommodate choice.

Trained People to Build, Maintain, and Operate these Resources

- Expectation that designers will invite people with disabilities to be beta users of all new products and service offerings recognizing that this class of user is both more demanding of functionality and more likely to quickly adopt a capability that offers real advantages. This design approach has unfailingly promoted greater ingenuity and innovation for many years, however, it has not been well known or consistently applied until recently.

- Expectation that designers with disabilities are more likely to stimulate increased design foresight for range of functionality and mode options in their organizations.

- Businesses that offer separate special customized products and services to meet needs of people with disabilities in a manner that accommodates choice as an afterthought will be at a distinct disadvantage to businesses fully integrating the choices of people with disabilities early through universal design and pilot demonstrations that include people with disabilities.

- Businesses will advertise their products and services as "access-screened" in a manner similar to being "green" or environmentally conscious. Perhaps a AAAS rating for "Application Adequacy for Accessibility Services" or a Seal of Accessibility as advanced by the Electronics Industry Association could be utilized.

- Businesses will expect federal pilot demonstrations to demonstrate how the accessibility of products and services can be advanced in the NII. There will a strong emphasis on access performance and reliability benchmarks for universal design in public and private interoperability testbed labs.

- Businesses will expect opportunities to showcase how they are investing in universal design to competitive advantage.

PART IV: How Are We Going To Get There?

This section addresses the scaling opportunities afforded through the NII to establish the leadership, policy, and marketplace roles and alliances necessary to ensure that the design of the NII will meet national expectations for breaking down barriers. These expectations can only be fulfilled by building choice and full usability for people with disability into the development of the NII.

Strengthen Market Pull — Current Effort Level Can Not Ensure Uninterrupted Access

Although the Federal Government in its role as a major employer and information technology consumer is taking steps to use its "buying power" to communicate to industry its need for information technology products and services that are usable by people with disabilities, this process must be scaled up in priority and include pilot demonstration activities in order to shape the capabilities needed earlier in the technology design cycle.

Agencies are demonstrating progress in formulating access policies and meeting current employee accommodation needs; however, increased attention is needed on leveraging market demand to ensure long-term uninterrupted access as future technologies are introduced and the information infrastructure proceeds. The current restricted usefulness of graphical user interfaces by blind users represents inadequate foresight in the marketplace to changing needs. Today blind users face graphics-mode-only applications whose designs neglect to accommodate choice, thus providing marginal utility of popular applications that have been fully utilized for more than a decade. Discussions in recent White Papers on the information infrastructure will need to be expanded in order to adequately address requirements of people with disabilities to the NII.

At a time of rapid technological change, the needs and requirements of customers with disabilities must be fully integrated in all technology development, replacement, and refreshment initiatives. Realizing the full benefits of the NII also depends on the development of open system standards. Without these open systems, small firms developing application devices important to individuals with disabilities will be crowded out of markets by larger, more established firms.

Fortunately, industry champions for improved access within large computer companies report that they are actively seeking greater evidence that equitable access is a high priority customer requirement of the government's information infrastructure.

Leadership by Example

Although the Federal Government is commonly associated with technology push R&D funding, within the information technology arena, the Federal Government also has a unique role as buyer for the largest and most complex information environment in the world. The ability of the Federal Government to demonstrate technology foresight in the marketplace can have a significant impact on the quality of life of people with disabilities. This consumer foresight can accelerate the readiness of the U.S. information industry to respond to similar application challenges beyond the Federal marketplace and abroad. The Federal Government should strengthen its investment commitment to universal design in order to achieve not only equal access to NII by all Americans, but also to recognize the innovation incentive it provides to industry to better prepare for consumer interface demands globally.

The Office of Science and Technology Policy is currently providing an example of LEAD by Design by assessing how well a new White House information service can be used by people with disabilities. This action will signal — in a manner that echoes tapping on the Liberty Bell during the first transcontinental call — our national commitment to an information infrastructure that will deliver in terms of global competitiveness and in a manner that liberates the expressiveness and amplifies the dignity of all Americans.

New Roles and Alliances

Deploying the National Information Infrastructure (NII) in a manner that promotes universal service, access to government information, and technological innovation with performance benchmarks for customer choice, equal opportunity, and convenience will provide the needed context for the following actions:

- Due to the high stakes requirements of people with disabilities, establish a citizen participation mechanism or use an existing capability such as Americans Communicating Electronically (ACE) to ensure that citizens with disabilities have the means to give input and feedback directly to NII planners and developers throughout the process. This is the NII category of customer with great need and at great risk for being well-served by the NII.

- Establish pilot demonstration partnerships among regional associations of people with disabilities; regional business innovation and/or industrial design consortiums; regional federal laboratory consortiums; and regional rehabilitation engineering centers.

- Increase collaboration among committed individuals involved in next generation design within universities, industry, and Federal laboratories to provide the focused technology push to human interface technologies that will readily accommodate capabilities required by people with a wide range of preferences, abilities, and disabilities.

- Increase collaboration among Federal, State and private sector organizations to operationalize performance benchmarks and showcase pilot demonstrations of infrastructure capabilities that also offer improved and uninterrupted access by people with disabilities.

- Human interface technologies that accommodate a wide range of user needs will become recognized as a critical technology in the missions of the Federal High Performance Computing and Communications Program, the National Telecommunications and Information Administration, the Federal Laboratory Consortium, and the Technology Reinvestment Project of the Advanced Research Projects Agency.

- Increased educational opportunities for human interface designers to learn how to meet customer requirements for accessibility through university/industry/disabled community partnerships that improve industry foresight to this changing global need.

Incorporating the Needs of Americans with Disabilities in New National Legislation

- How should the Communications Act of 1994 (S.1822) protect and advance universal service in a manner that more explicitly includes people with disabilities?

- How should the Antitrust Reform Act of 1993 (H.R.3626) and the National Communications Competition and Information Infrastructure Act of 1993 (H.R. 3636) fully reflect public interest in universal design, universal access, and customer choice?

- How should intelligent interfaces that accommodate disabilities and abilities be acknowledged as a competitiveness factor in the National Competitiveness Act of 1993 (S.4)?

Performance Benchmarks for Accessibility

- How should the design needs of people with disabilities become operationalized as an integral aspect of all NII development initiatives?

- What performance benchmarking mechanisms are needed to ensure that innovations such as information kiosks, electronic town meetings, electronic voting and other interactive services can be fully utilized by people with disabilities?

- How can the design needs of people with disabilities be an integral principle of ongoing federal programs advancing the NII such as the High-Performance Computing and Communications Program?

- What mechanisms are needed to coordinate and accelerate the technology transfer benefits between federal programs serving

people with disabilities and High-Performance Computing and related advanced technology and technology reinvestment programs?

- How should application guidelines for universal access be integrated into the National Telecommunications and Information Administration grants program designed to support demonstrations of new telecommunications technology applications?

- What mechanisms exist for regulatory agencies such as the Federal Communications Commission to communicate with disabled citizens on telecommunications issues?

Conclusion

Full participation by citizens with disabilities in the design, pilot demonstrations, and implementation of NII applications is a national priority. Collaborative support mechanisms within the Federal and State Governments and private sector need to be strengthened to serve as communication conduits between citizens and NII developers. NII investments need to include performance benchmarks to ensure that applications can be fully utilized by people with disabilities.

The NII must accommodate choice in order to deliver on its promise of universal access. The unprecedented convergence of information technologies only amplifies the possibilities - accommodating choice provides a focal point for early and far reaching benefits.

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Supply and Demand of Electric Power and the NII

DRAFT FOR PUBLIC COMMENT

PART I: What is the Application Arena?

Description of Electric Power Supply and Demand

Information technology (IT), computing, networking, and telecommunications are key technologies in the creation of dynamic markets for electric power, the efficient and timely management of electric utility operations, and electrical energy demand management. The prospect of major improvements in the networking, telecommunications, and computation infrastructure of the United States under the National Information Infrastructure (NII) initiative offers interesting opportunities and raises important issues for electric power utilities. [1]

Residential Scenarios

Improved computing, networking, and telecommunications would permit the widespread adoption of variable electric utility rates (either seasonal time-of-use or real-time pricing), and intelligent control of residential electric loads. A homeowner would use either a personal computer or a sophisticated interactive cable TV system as the user interface, from which the customer could view a detailed electric bill showing charges for individual large appliances, change thermostat settings, and schedule timer-driven appliances. Wireless and speech understanding interfaces will make such interactions easier. Consumers might be able to choose electric power vendors in much the same manner as they now choose long distance telephone companies.

A microprocessor-based electric meter would record power charges as a function of the varying price. Smart appliances (water heaters, dryers, etc.) could be programmed to run during off-peak periods when electricity was cheaper. Smart thermostats would be set to permit higher temperatures during periods when the occupants were absent, or when electric charges were exceptionally high. Either a timer or phone call could be used to start air conditioners/heaters or other appliances in anticipation of occupant arrival or awakening. The same system would also serve as a home security system, alerting the resident (or security service) of fire or intruders.

Some appliances, such as electric car battery chargers, hot water heaters, etc., might be on selectively interruptible power. During peak load periods or emergencies, the utility could interrupt these appliances to shed excess load. In exchange the residential user would receive a cheaper rate for this portion of electricity usage.

Commercial Scenarios

Commercial electricity users, such as operators of office buildings or other commercial buildings, also would benefit from improved computing, networking and telecommunications with their electric utilities. Existing Energy Management Control Systems (EMCSs) could be adapted or upgraded to deal with real-time power pricing. More detailed billing information will permit users to identify and itemize the cost of each end-use (air conditioning, large appliances such as copiers, individual room lighting, etc.). Building operators would find it advantageous to cool their buildings at night or during the early

[1] These issues also are applicable to some other energy industry operations, such as gas utilities. They also have implications for US energy policy as developed and implemented by the Department of Energy (DOE). Issues for the DOE are addressed more directly in Part III.

morning and to allow them to warm up somewhat in the afternoon. This would reduce power usage charges for air conditioning during peak load periods on hot afternoons. EMCSs could compute optimal cooling schedules from power pricing and weather forecasts, and automatically execute them.

Large commercial customers would be able to purchase electricity from several different vendors, paying separately for power transmission and local distribution to their site. Vendors might well include independent power producers, neighboring utilities, etc. Customers would be able to choose the both the electric power vendor and the quality of service (frequency of interruptions, allowable transients). Those who wanted higher quality power would pay more. Some commercial customers would find it worthwhile to operate co-generation facilities, selling excess power to the utility.

Some building operators might find it worthwhile to install cool storage capability in their buildings, making ice during off-peak periods, and melting the ice to cool air during hot afternoons.

Utility Operations Scenarios

The potential application of the NII to utility operations can be viewed either opportunistically (What could one do with an NII?) or from an applications requirement specification viewpoint (What is needed from an NII to support proposed changes in utility operations?).

The fundamental issues to be addressed are:

- What impact could a widely deployed NII have on utility operations, capital requirements, etc.? Alternatively, how does possible use of the NII for utility operations impact the communications requirements of the NII?

- What impact will a widely deployed NII (and attendant changes in utility pricing power policies) have on energy conservation? Alternatively, what NII capabilities are needed to support real-time pricing and other energy conservation strategies?

- Are the economic advantages to electric utilities (especially, reduced capital equipment for peak power demands) sufficient to justify the construction of wideband communications to residential, commercial, or industrial sites?

- How will a widely deployed NII facilitate market competition in the electric power industry? Alternatively, how will electric power markets, increased power wheeling, disaggregated utilities, and distributed power generation (e.g., from renewable sources) affect NII requirements?

The question of whether electric utilities should supply wideband communications to residences, commercial and industrial sites is of great interest to the electrical utilities. It has been suggested that the entry of electric utilities into the telecommunications business may offer significant economic benefits, by increasing competition and accelerating deployment of the NII. Such potential economic advantages are not discussed further in this document due to lack of information. This subject will be considered in a study sponsored by the Department of Energy (DOE), the Electric Power Research Institute (EPRI), and the Edison Electric Institute (EEI), to be completed later in 1994. In addition, the study will examine regulatory issues, especially the regulatory Holding Company Act, and the financial means used by utilities for developing their wideband networks.

The primary focus in this paper will be the implications of improved telecommunications for utility operations, energy conservation and utility capital requirements. Note that the beneficial impact of the NII on electric utility operations and energy demand management arises from the conjunction of improvements in the cost and capabilities of telecommunications, microprocessors, and power control devices. Cheaper communications makes it feasible to communicate rapid price changes and control messages. Cheap, fast microprocessors and improved power semiconductors make it feasible to implement variable price power metering, and for electric power customers to quickly respond

to price changes and control signals. The ability of utilities to directly control low priority loads should reduce the frequency of power outages and brownouts. The energy savings should help defer the need for and cost of new power plants.

Improved Capacity Utilization

One of the most important applications of the NII concerns potential improvements in utilization of generation, transmission, and distribution capacity, effectively improving capital productivity. Such improvements would reduce the capital costs of electricity and the need to construct new power plants. Capacity utilization improvements could arise from the following strategies:

- Smoothing of peak power loads, via real-time load management — by real-time pricing and/or direct load control signals. Increased charges for peak period power either via time-of-use pricing, or real-time (e.g., weather dependent pricing) are expected to encourage power consumers to reduce peak usage, e.g., by rescheduling appliance usage, by thermostat adjustments, or by using off-peak thermal storage.

- Reducing spinning reserve generation capacity by the use of rapidly interruptible loads — in which customers sell options to the utility to interrupt (a portion of) their service in emergencies — turn off water heaters, etc.

- Less conservative operation of transmission line facilities via more detailed thermal monitoring, real-time system load flow and stability analyses, and rapidly interruptible loads.

Energy Conservation

In the United States, peak power loads for many utilities occur on hot summer afternoons due to air conditioning loads. Development of the NII would permit utilities to engage in real-time power pricing (RTP) to reflect the true costs of electricity usage, resulting in higher charges for peak period power usage. A number of customer responses are possible which would reduce power costs. Thus, increased peak power pricing would accelerate the replacement of older inefficient air conditioners with newer more energy efficient air conditioners. Factors of two in energy efficiency are attainable compared to typical decade-old equipment. Furthermore, price-sensitive air conditioner controllers could relax thermostat settings during peak demand (price) periods. Clock driven, or dial-up controllers could be used to turn on air conditioners shortly before occupants return to their residences. Smart clock-driven thermostats now do this for heat pump based heating and cooling systems.

Disaggregated Utilities and Dispersed Generation

Improved telecommunications and computing will facilitate real-time control of both the power supply system and loads. This will support a wide range of approaches to create more competitive and efficient markets for electric power. Electric utilities could be disaggregated into separate generation, transmission, and distribution organizations with time, location, and service priority variability in pricing. It is anticipated that this would lead to cheaper power by creating more competitive markets for power generation by independent power producers. Such scenarios pose complex issues in pricing and economically efficient power dispatching, etc.

The most ambitious scenarios envision national trading markets in electrical power, comprising a variety of options to permit or cover interruptions such as spot markets and futures contracts. It is envisioned that such markets would function like current financial markets.

Another consideration is that time-varying pricing may change the attractiveness of various renewable energy sources. Renewable energy sources which exhibit availabilities similar to the power demand, such as solar energy sources in summer peak load utilities (common in the United States), may prove more obviously valuable, and hence lead to faster adoption.

It has been suggested that the weather dependence of renewable energy sources may require increases in utility reserve generation capacities. Thus more efficient provision of generating reservesvia the use of real-time pricing or interruptible service contracts could facilitate the integration of renewable energy sources into the utility grid.

Distribution Automation

Other issues of interest to utilities (and DOE) are the use of improved telecommunications to permit distribution automation, including remote monitoring and diagnosis of the electrical power distribution system. At present most utilities only have monitoring down to the substation level. Distribution automation offers the possibility of reduced labor costs for maintaining distribution facilities, and more rapid response to power failures. The impetus to adopt further distribution automation is also due to the increasing availability of improved, more economic electronic sensors and power semiconductor devices.

Telecommunications Requirements

One central question to be addressed is: What levels of telecommunications and computation infrastructure are required to support various mechanisms of time-of-use, real-time, and/or priority-of-service pricing contracting, billing, and load management?

Some of the benefits can be obtained by simple mechanisms, such as seasonal time-of-day pricing or direct utility control of hot water systems. These mechanisms would perhaps require more complex power meters, or broadcast load control signals, but not necessarily wideband point-to-point communications. Other scenarios, such as multiple service priority levels, utility monitoring (and possibly control) of end use energy consumption, operation of disaggregated utilities (spot markets in power, control of dispersed generators, etc.) variously would require higher-bandwidth, two-way, point-to-point communications.

There are also a number of traditional (voice) and multi-media (i.e., video) applications that are of interest to electric utilities. Examples of multi-media applications include process control video monitoring, tele-conferencing for routine and emergency operations, and distance learning. Communications requirements for emergency response (e.g., to large storms, fires, earthquakes, and hurricanes) are akin to military command and control systems, requiring mobile access and multi-media (voice, data, Geographic Information Systems (GIS) data, remote video).

The most appropriate telecommunications infrastructure may depend on variables such as population density, geography (availability of line-of-sight transmission routes), existing communications infrastructure, etc. Thus, wireless (radio frequency (RF) or satellite) communications may be more appropriate for rural areas, while fiber optic links would be more appropriate for urban settings. Thus a utility communication architecture should be able to adapt to a variety of communications media.

What is the Public Interest in Promoting the Application?

Economic Impacts[2]

Potential economic impacts of an improved NII for energy conservation, electric utility operations, and energy demand management include both direct and indirect economic impacts.

The most obvious **direct economic impact** will be due to reduced peak power demand. This will reduce the requirements for peak generating capacity, transmission and distribution capacity. Recent experiments (at AEP, PGE, and Gulf Power) indicate coincident summer peak load reductions of 1.5 to 3.0 kilowatts (kW) per residence. Allowances for transmission losses and reserves imply that peak generating capacity could therefore by reduced by 2.0 to 4.0

[2] The following discussion of economic benefits is adapted from a paper by Steven Rivkin for the Edison Electric Institute (EEI) which is based on the experience of the Entergy Corp. trials.

KW per residence. EEI estimates peak generating capital costs at $436/kW for natural gas fueled combustion turbines (the most common peak load power plants built today). Thus one would expect to see a capital saving of $872 to $1700 per household. Based on the 1990 figure of 92 million occupied housing units in the United States, a reduction in required generating capacity of the order of 180 to 360 gigawatts (GW) could be expected. The low end estimates would amount to about $80 billion savings in capital expenditures.

However, this estimate appears to be too large. The residential sector accounts for one third of the total U.S. electricity demand. Since total summer generating capacity in 1990 was 690 GW, and reserve capacity was approximately 20 percent, total peak residential consumption was presumably about 185 GW. Thus extrapolating EEI's estimate to the entire United States effectively assumes elimination of the entire residential electric demand — this is clearly unrealistic. There are two likely sources of error: the sample for the studies frequently are high consumption residences not representative of the entire housing market, and the summer peak load is distributed differently over time and geographic regions. Potential capital savings of $80 billion is a more likely upper bound; achievable reductions probably would be half this number.

Spinning reserve generating capacity (typically 5-7%) could be reduced by substitution with rapidly curtailable loads. If spinning reserves could be reduced by 1% of total summer load (690 GW in 1990), this generating capacity requirements could be reduced by 7 GW, saving about $3 billion in capital expenditures.

EEI estimates meter reading costs $6/residence/year, thus automatic meter reading could save another $0.55 billion annually

Distribution automation is expected to also largely eliminate power theft by permitting more detailed monitoring of power individual and aggregate power usage. Losses due to power theft are variously estimated at between 0.5% and 1.0% in the power industry. U.S. electricity consumption in 1990 was $177 billion. Thus one would expect another $0.8 to $1.7 billion in annual savings.

Energy conservation (reductions in aggregate electric power demand, not merely peak demand) is estimated by EEI at 5%. Estimated savings would be due to either higher peak period prices, more attentiveness due to the availability of more detailed billing, improved capability to selectively control lighting and other loads, and improvements in energy efficiency due to capital equipment replacement. The average U.S. residential electric bill for 1991 was $777 or about $39 per residence/year. With total U.S. residential electricity consumption for 1991 at $98 billion, overall annual residential savings could amount to $5 billion. U.S. electricity consumption for commercial buildings was $56 billion, thus a similar estimate would be $2.8 billion annual savings in the commercial building sector.

EEI computes there will be significant savings ($338/residence over 20 years, using a 10% discount rate) because off-peak power will be produced from coal, which is cheaper than the natural gas used to fuel peak generating units. EEI assumes that natural gas prices rise faster than coal. EEI also assumes a savings of $52 per residence over 20 years in operations and maintenance costs because coal-fired units are cheaper to operate and maintain than gas-fired peaking units.

Remote service activation/deactivation was estimated by EEI at saving one trip per residence every 7 years. EEI estimated the cost at $50/trip. However, this is only relevant if either the gas and electric service are provided by different companies (since otherwise a utility representative would visit the residence anyway to restart the gas service). Finally, EEI estimates $59 per residence over 20 years in savings in productivity improvements in demand side management impact analyses.

Additional savings in distribution operations costs and losses to customers due to loss of service will accrue because of faster outage restoration via distribution automation (i.e., improved telecommunications, GIS, and facilities

management (FM) system. There currently are no estimates of these benefits.

The EEI study of the Entergy Corporation trials suggested that the savings in utility operations and capital requirements would effectively cover the cost of deploying the NII. Alternatively, other applications of the NII could partially amortize the cost of providing the communications infrastructure for electric utility applications. EEI assumed $850 per residence for fiber/cable, communications equipment, intelligent gateway/meter, and appliance wiring and controllers and a cost of $312 per residence over 20 years (10% discount rate) for operations and maintenance. Total costs were $1172 over 20 years; total benefits (exclusive of other NII applications) were $1545 over 20 years.

Note that reduced peak power demands can arise from selective load shedding, rescheduling industrial (or consumer) activities (into off-peak periods), by resetting thermostats during peak periods, by customer provided electrical power storage (batteries, fly-wheels, fuel cells) or thermal storage (heat or cold), or by adoption of more efficient appliances, lighting, heating, ventilating and air conditioning (HVAC) equipment, or additional building insulation.

Thermal storage can be provided, for example, by operating ice-makers at night and using the ice for air conditioning in daytime. Peak period pricing, either seasonal time-of-day or real-time, can provide the economic incentive for installation of thermal storage in commercial buildings. The economic rationale is that thermal storage may be cheaper than building the corresponding peak generating, transmission, and distribution facilities.

In the continental United States many electric utilities exhibit peak power demands in summer months in the late afternoon due to air conditioning loads. Two-fold improvements in air conditioner efficiencies have been achieved over the last decade, but many customers have not replaced their air conditioners, in part because present residential electricity tariffs do not signal the full costs of peak period electricity, that is, the price is generally not time dependent. We expect that electricity tariffs which fully account for the costs of peak period electricity supply will lead to substantial increases in the price of power during peak periods — typically hot summer afternoons when residential consumers are likely to be using their air conditioners. This could greatly accelerate replacement of inefficient air conditioners.

Indirect economic impacts can be generated through NII impacts on utility pricing. Peak power pricing could encourage independent power producers to develop better load coincident power sources. Examples of this include solar power in the South and Southwestern United States and possibly wind power generators in more northern regions. This may hasten the adoption of some renewable energy sources. Peak period power pricing and direct utility control also will help supply power for large fleets of electrical vehicles (i.e., recharging at night, interruptible power for daytime recharging).

Improved information infrastructure (tele-communications and computing) appears essential to operation of large disaggregated utilities (those with many independent power generators). Improved information infrastructure is also needed as the electric power market grows more complex to support service reliability differentiation, with accompanying price variability.

More accurate pricing of power transmission and distribution services will lead to location dependent power prices (at least for commercial and industrial customers). Customers located far from generating facilities will face higher prices which in some cases would favor customer sited co-generation or renewable (solar, wind) facilities. These facilities do not incur transmission costs, but may have higher capital costs. This effect is already seen in extremely remote customers such as remote cabins, microwave relay towers, and paper mills. Increasingly competitive markets for power are expected to partially reduce inter-regional variations in the price of power, as users in more expensive regions import power from regions with less expensive power. For example, California currently is importing less expensive hydropower from the Northwest. The capital

costs of transmission facilities and transmission losses will preserve some regional variations in power prices.

Environmental Impacts

Environmental benefits are more difficult to quantify. Nevertheless, energy conservation should lead to proportionate reductions in air pollution (particulates, NO_x, and sulfur-dioxide especially) and CO_2 emissions due to consequent reductions in fossil-fueled generator operations. This would reduce greenhouse induced climate change. Note however that shifting some peak loads from natural gas fueled peak generating facilities to coal-fired base load generating plants will partially offset the pollutant reductions due to conservation. These comments do not apply if base load generation is nuclear or renewable sources such as solar, wind or hydropower.

More sophisticated utility control systems could also permit the dispatching of power plants according to their pollutant production (NO_x and sulfur dioxides) on smoggy (high ozone) days. Note that coal plants are typically more polluting than natural gas. Some 55% of the U.S. population reside in metropolitan areas which do not comply with EPA ozone pollution regulations.

The availability of cheap off-peak and interruptible daytime power for charging batteries or flywheels of electric vehicles also offers the prospect of reduced emissions. Electric power plants produce negligible hydrocarbon and carbon monoxide emissions, unlike autos. Furthermore, even their NO_x emissions are less than comparable emissions from gasoline or diesel vehicles. Finally particulate emissions at power plants are easier to control than from diesel vehicles. Of course, if electricity is generated from nuclear, solar, wind, or hydropower there are no emissions of air pollutants or greenhouse gases. Such considerations are the basis of California's new regulations requiring automobile manufacturers to produce a certain proportion of electric vehicles.

Finally, one would expect that increasingly competitive markets for electric power will force utilities to exert increased efforts to reduce the costs of generating electricity. Unfortunately, this may lead to increased resistance or evasion by utilities of costly environmental regulation concerning emission of air pollutants. Additional enforcement efforts may be required.

Income Distribution Considerations

The effect of real-time pricing (RTP) or time-of-use (TOU) pricing is to increase the price of electricity during summer peak load periods and thus discourage electricity use during these periods. Poor households are likely to be significantly impacted. There are indications from studies by the medical examiner of Philadelphia that a substantial number of deaths among the elderly poor during major heat spells are due to lack of adequate ventilation and/or air conditioning.

Because the major energy savings (both peak demand reductions and conservation) presumably will accrue from households with large energy consumption — typically large affluent single family houses — utilities will favor wiring affluent suburbs over urban apartment districts, especially poorer urban areas. This has been conmfirmed in existing trials. Thus some urban communities effectively may face communications red-lining, further aggravating the isolation and undesirability of these communities.

Trade Considerations

Efforts to accelerate the introduction of smart appliances or intelligent utility gateways by means of regulatory mandates, subsidies, or tax credits for appliances meeting particular standards may be seen as non-tariff trade barriers and might therefore become subject to litigation under NAFTA or GATT.

Demand for more efficient or more intelligent appliances may favor foreign producers. Recall that foreign vendors have captured a very large share of small fuel-efficient U.S. automobile market. Also, foreign vendors (especially

European vendors) are the major suppliers in the United States of more efficient front-loading washing machines. Foreign vendors also lead in the commercial production of electric cars.

PART II: Where Are We Now?

Communications

Electrical generation facilities and transmission grids are extensively automated and supported by extensive data communications networks, running primarily on utility company owned telecommunications facilities (fiber optic and microwave) rather than common carrier facilities. Communications protocols vary by utility and are often proprietary. Some utilities, such as Pacific Gas and Electric, employ the Internet TCP/IP protocol suite. Use of the Internet or public access telecommunication networks is rare. There is some use of communications circuits leased from common carriers. At present utility communications networks generally extend to the substation level, but not beyond. Distribution automation (beyond the substation) is just beginning at most U. S. utilities, although some utilities have made substantial progress.

There are few two-way data communications facilities between electric utilities and their customers in the United States The exceptions are large (mostly industrial) customers, who may receive real-time pricing information via modems over phone lines. Direct load control of water heaters is widespread in some communities, relying primarily on one-way communications via broadcast or packet radio.

In cases where two-way communications between utilities and customers exists, communications for distribution automation (DA) and automatic meter reading (AMR) is still largely via 9.6 kilobit/sec (or slower) packet radio, power line carrier systems, or twisted pairs. While packet radio seems to be the preferred communications system for new DA and AMR applications, some utilities are deploying fiber optic communications for distribution automation.

Customer Sites

Many commercial buildings have some sort of Energy Management Control Systems (EMCSs), for heating, ventilating, and air conditioning control (HVAC), and for lighting controls. Usually these EMC systems are PC-based controller communicating over twisted pairs or power lines via proprietary communication protocols. Control capabilities are often crude (only on/off), with variable speed motor controls for ventilation blowers just being deployed recently. In many cases EMC systems lack the ability for fine-grained control of lighting, i.e., control of individual fixtures. Most customer sites have either no data communications with the utility, or perhaps some facility for automatic meter reading. Residences typically employ the X-10 protocol over power lines, mostly for remote or automatic (timer-based) lighting controls, fire and burglar alarms. Timer controlled thermostats are found in many households. Very few households have PC-based control systems.

Metering and Tariffs

Nearly all residential sites still employ electro-mechanical meters which must be manually read. Some commercial sites have electronic meters (with more flexible pricing) which can be updated and/or read remotely (via phone lines or radio packet switching).

Most residential customers in the United States do not have time-dependent electricity tariffs. However, some (larger) residential customers have 2-period (peak/off peak) time-of-use pricing. Commercial and industrial customers often pay time-of-use (TOU) prices (usually only 2 time periods - peak/off peak). Many commercial and industrial customers also pay a surcharge based on peak usage during each month. A few large customers pay "real-time prices" (RTP), which typically change on an hourly basis, usually with 24 hour advance notice (sometimes shorter notice, e.g., 2 to 4 hours).

Security

Communications security presently relies primarily on the fact that utility communications occur on private communications circuits. Passwords are used to control access to computers, but digital signatures for authentication are not presently employed.

Interoperability

Historically, the bulk of communications for electric utility operations relied on proprietary communications protocols, with little provision for interoperability among utilities or customers. Recent years have seen deployment of open systems Energy Management Systems for management of electric utility operations typically employing Unix, Internet TCP/IP protocols, and relational databases. There is some use of the ISO OSI (Open Systems Interconnect) communications protocols such as X.25. Some formerly proprietary communications protocols employed in SCADA (Supervisory Control and Data Acquisition) systems for monitoring the transmission network and substations are being standardized. Database interoperability (to the extent that it exists in production systems) typically relies on commercial database gateway software, often using IBM's DRDA (Distributed Remote Data Access) protocol, rather than the ISO (International Standards Organization) RDA (Remote Data Access) protocol. There is widespread use of relational database systems and the SQL query language. However, the real-time component of databases for utility operations is still maintained in proprietary main-memory databases. Practical database or applications interoperability requires the adoption of standardized database schemas and applications program interfaces, which are not yet in place.

Utility Computations and Control

At present most utilities rely on off-line computations for computationally intensive aspects of utility control computations such as network security (i.e., failure contingency) analyses, and optimal power flow computations. The ability to perform these computations in real-time would be desirable.

Existing Research Programs

Federal Research & Development Programs

There are several federal agencies supporting research, development, and policy analysis in areas relevant to NII applications for management of electricity demand, supply and delivery: The Department of Energy (DOE), the Environmental Protection Agency (EPA), the Federal Energy Regulatory Commission (FERC), the National Science Foundation (NSF), and the National Institute of Standards and Technology (NIST).

The **DOE Office of Utility Technology** has programs in: renewable energy ($179M in FY 94, mostly photovoltaics), transmission and distribution ($6M in FY 94, of which $3M for real-time systems control), $3M for high capacity transmission technologies (mostly HVDC), and $1M for systems analysis), energy storage ($6M in FY 94, mostly batteries), integrated resource planning ($7M in FY 94), superconductivity ($21M in FY 94).

The **DOE Office of Building Technology** has a budget in FY 94 of about $100M. Its research program, covering both commercial and residential buildings, includes EMCSs, real-time pricing, building codes and appliance energy efficiency standards, energy efficient lighting and windows, and evaluation of demand side management (i.e., conservation) programs.

The **DOE Office of Industrial Technology** is concerned with energy efficiency improvements and waste minimization of industrial processes and activities (manufacturing). It is also concerned with EMCS and real-time pricing for industrial customers.

NSF Engineering Directorate includes a Power Systems Program which has supported theoretical work on utility control algorithms. The program supports theoretical research in power systems operations, including control policies

and computational algorithms, and power systems security analysis. The budget for FY 94 is $3.1M.

FERC has responsibility for regulating access to transmission networks and has supported work in regulatory policy analysis for transmission pricing.

EPA Energy Efficiency Program is interested in improving energy efficiency as a means of reducing air pollution and emission of greenhouse gases. This program is known as the Energy Star program. It includes efforts to encourage the adoption of more efficient lighting (Green Lights), a voluntary energy efficiency standard for personal computers.

NIST has an extensive program in communications protocols standards development and conformance testing, especially concerning the ISO OSI protocols. Particularly relevant t to this discussion are its efforts in assisting the development and testing of BACnet (Building Automation and Control Network) with ASHRAE. Also relevant is NIST's work in the development of the DSS (Digital Signature Standard) to facilitate authentication of digital messages. NIST's Building Controls program is concerned with a variety of questions (modeling, control policies, equipment, etc.) concerned with the control of building environments (thermal, ventilation).

In addition to the energy related research programs mentioned above the High Performance Computing and Communications Program, specifically the National Research and Educational Network and the Information Infrastructure and Applications components, have supported development of networking technologies suitable for the management of energy demand, supply and delivery.

Private Research & Development Programs

Entergy Corporation has conducted a trial of 50 homes, with fiber optics, and has asked for approval for a 30,000 residence trial. They believe that the savings in capital investment (for generation, transmission, distribution) will more than compensate for the cost of installing the fiber optics. They have also estimated that utility applications will require (at most) 5 percent of the bandwidth to the homes.

Electric Power Research Institute (EPRI), Consolidated Edison, Pacific Gas and Electric, and Marriott Hotels have undertaken a project to examine the impact of real-time pricing at two Marriott Hotels, one in New York City and one in San Francisco. The New York City hotel project is further along, but was constrained by existing controls to only on-off control for many functions. The San Francisco hotel has more sophisticated controls, permitting (for example) variable speed motor controls for ventilation fans, etc. The San Francisco hotel will use pre-cooling of ballrooms and meeting rooms. The San Francisco hotel also has ice thermal cool storage facilities.

EPRI has initiated a new research and development program in "Integrated Information Systems Integration," to be formally inaugurated in 1995. This will support collaborative R & D in: broadband utility telecommunications, information systems integration, and upgrading legacy systems.

EPRI also has sponsored work on development of a utility/customer communications protocol based on the OSI protocol suite. Numerous programs with a strong communications component using OSI standards UCA/MMS and DAIS/RDA are now undergoing field trials and preproduction demonstrations. Many will complete in the 1994 -95 time frame. Notable among these are the following:

- **PG&E North Bay Division:** Applications in five key business areas of system utilization, demand side management, curtailment verification, information to customers and system information for business planning. These are being introduced in parallel with legacy systems.
- **Kansas City Power & Light:** Generalized access to heterogeneous databases using DAIS servers as front ends to legacy databases. The system will include a GUI application development tool, RDA/SQL

protocols and both UNIX and MS Windows workstations.

- **Public Service Electric & Gas Co.:** A Generation Energy Cost System accessing distributed databases. It will provide users a uniform view of the data via OSI/RDA communications protocols.

- **Ogelthorpe Power Corp.:** An integrated Distribution Automation, demand side management project for Electric Member Cooperatives. This system will integrate systems of different EMCSs with their Generation and Transmission utility. The project will implement Inter-Control Center Communications using ISO 9506 MMS protocols.

- **United Power Association:** A project for substation and feeder automation. It includes the monitoring of substation equipment and meters, control of sectionalizing switches and capacitors.

- **Florida Power Corporation:** A project performing remote distribution capacitor bank control, validation of load management receiver operation and remote meter reading.

- **Georgia Power Company:** The integration of a new Distribution SCADA system with GIS facilities mapping. This will entail two communications systems. In an urban environment a point to multipoint wireless system will be used. A packet-switched wireless network will be used in a rural setting.

- **San Antonio City Public Service Board**: Data communications over both local and wide area networks providing database access and integration services.

- **Union Electric Company:** A project using radio controlled feeder switches. It will also determine feasibility of collecting and using data from automated switch locations for operations, engineering planning and design.

- **Northern States Power:** A wireless project to demonstrate the use of ISO9506 (MMS) in several facets of an existing Distribution Automation project.

- **Allegheny Power Service Corp:** An advanced power line Communications project using spread spectrum modulation and sophisticated signal processing to reduce the effects of power line noise and interference at bit rates of over 1200 b/s.

- **EPRI Contractors:** A project to demonstrate the use of a single real-time messaging protocol for intercontrol center communications.

- **Houston Lighting & Power:** The Electricity Reliability Council of Texas (ERCOT) with HL&P has a project which supplies data from ten Control Area Supervisory Control and Data Acquisition (SCADA)/ Energy Management Systems to two Security center computers for reporting and analysis.

- **EPRI and Contractors:** An integrated Protection, Control and Data Acquisition project to define an open system for communications between all substation intelligent devices. Such a system will act as a backbone for a modern substation protection, data gathering control and diagnostics.

- **EPRI Customer Communications Gateway:** This is an evolution of an EPRI developed gateway product for 2-way utility -customer communications. It will implement MMS using the reduced OSI stack. It will be designed for communications over both physical and wireless media.

- **Roxboro Automation Project:** This project is intended to provide efficient and useful plant-wide automation technologies. The project will investigate various European and Domestic advanced control strategies, plan-wide data communications and data access along with standardized man-machine interfaces plant dynamic simulation and load dispatch. Adherence to

international system standards will be closely followed.

- **Philadelphia Electric:** Prototype development and implementation of a predictive maintenance or Operations and Maintenance workstation. This system will provide interoperability among disparate computer platforms for various power utility applications and will be portable to other power plants.

- **EPRI Knowledge Delivery and Collaboration Network:** EPRI is engaged in a continuous improvement program of developing electric utility industry information services network EPRINET. This is an Internet -like environment which supports client server applications for technical research information retrieval, bulletin board systems, electronic mail, directory services, authentication and transaction processing. EPRI has used a combination of OSI and TCP/IP technology, WAIS and Mosaic. EPRI has begun a program of Electronic Document Delivery so as to provide electronic options of full electronic browsing of compound documents and printed -on-demand. EPRI expects to implement new tools for browsing and collaborative work automation this year.

PART III: Where Do We Want to Be?

Issues for the Department of Energy

The issues confronting DOE fall into three major categories: economics, control, and informatics infrastructure. Studies are needed in the following areas: economic studies of various institutional and regulatory regimes for the electric utility industry, economic and regulatory policy studies of electric utility provision of communications services, and technical studies of computational algorithms, computational and communications infrastructure for utility operations and real-time demand side management. Economic issues have been discussed in Part I. Discussion of electric utility entry into telecommunications market is beyond the scope of this document.

Beyond the broad issues, DOE needs to identify the technical obstacles to deployment of these technologies and the research, prototype, or demonstration efforts needed to hasten adoption. DOE also needs to identify the most appropriate setting(s) and mechanisms for each aspect of the R&D effort.

Utility Control Computations

In the event that communications, control and computations components could be implemented widely into the power grid and customer sites, how then should one price utility services (power and transmission) and control the operation of the utility and customer loads? Large-scale computations are required to respond to such questions:

- **Load flow analysis** — Given specified loads and power sources, how will power flow through the transmission/distribution network? This information is used to determine transmission losses. Transmission line losses must be known to determine transmission service pricing and to assure that transmission lines are not permitted to overheat. Load flow analyses are conducted by solving a large system of simultaneous nonlinear (quadratic) equations.

- **Scheduling** involves the scheduling of generator plants outages for maintenances, refueling nuclear power plants, long term power purchases and operation of hydro-electric power plants.

- **Unit commitment scheduling** involves deciding when to commit the operation of large steam-based power plants. Such plants often require several hours to be brought up to full operation or to be shutdown. Typically unit commitment scheduling is done a day (or even a week) in advance.

- **Economic dispatch** concerns the real-time operation of the electric utility given the scheduling and unit commitment decisions. The utility must determine efficient policies

for purchasing, dispatching of generators, and load curtailment. This involves the solution of large optimization problems. Each iteration of the economic dispatch computation may involve solving the load flow analysis problem.

- **Pricing** — Prices for sales of power and transmission services must be computed. Transmission prices are affected by transmission losses which are a function of the load flow, and ambient air temperature. Note that the FERC sets policy for access and pricing of electricity transmission under the Energy Policy Act of 1992. One approach to computing transmission prices is to use the dual variables from the transmission capacity constraints in the economic dispatch computation.

- **Stability (or security) analysis** concerns the analysis of the vulnerability of the power systemdue to failures in generating or transmission equipment, failures of utility inter-ties, or unanticipated loads. At present such security analyses are performed offline, using pessimistic estimates of loads, transmission line capacities, etc. Operating policies and planned responses to potential failures are designed accordingly. Real-time computation of security analyses would permit higher levels of utilization of transmission facilities.

- **Fault diagnoses** involve the determination of the cause and location of problems with the generation, transmission, and distribution network from telemetry data.

All of these problems appear to become more difficult with disaggregated electric utilities and the arrival of large numbers of independent generators.

A number of these problems (e.g., load flow analysis) are very large expensive computations, typically performed off-line. They may be amenable to supercomputer, parallel or clustered computing, or distributed control systems. The ability to perform these computations in real-time may permit less conservative operation of the power system and more resilience in the face of failures.

Note also, that combining to the solution to several of these problems may produce more efficient solutions; e.g., combining load flow analysis, pricing, and economic dispatch. This is presently done for some off-line computations.

Applications of NII to Utility Operations

Applications of improved telecommunications to utility operations may be grouped into three categories: demand side management, transmission and distribution automation, and remote generation unit control. These applications primarily involve communications within a utility or between a utility and its customers.

Demand Side Management

- **Direct load management (DLM)** entails direct utility control of customer appliances to reduce peak power demands. Examples of loads which are common candidates for DLM include: electrical heating, air-conditioning , hot water heating (residential, hospitals, hotels, laundries), electric clothes dryers (mostly residential), dishwashers (mostly residential), electric ranges or ovens (mostly residential, for short periods).

- **Real-time power pricing (RTP)** is the use of frequently changing power prices (every 15 min or more rapidly during emergency operations) to encourage customer power conservation during periods of peak demand. The primary advantage of RTP over direct load management (by the utility) is that it permits more discretionary control by utility customer. This is sometimes important for residential customers in situations where there are constraints on appliance operation due to personal schedules. The issue is much more important for commercial and industrial customers, whose amenability to power interruption may vary widely according to

time-of-day or immediate workload, among other factors.

RTP also has some advantages over seasonal time-of-use (TOU) pricing. RTPs are adjustable for weather dependent load demand (based on temperature) and power generation availability (based on insolation, wind speed). Finally, RTPs can be adjusted to account for generator outages, transmission line failures, and availability and price of purchased power.

There is some question as to how responsive utility customers are likely to be to rapidly fluctuating power prices. While certain industrial or commercial activities can be rescheduled on a day's notice, often such activities are not effectively interruptible on shorter notice. Similarly, opportunities for modifying heating/cooling building operations are more substantial given 24 hour notice, than on shorter time scales.

- **Rapidly curtailable loads (RCL)** — Direct control of customer loads could be used to reduce requirements for spinning reserve generating capacity. Spinning reserves are maintained to cope with failures of generators and transmission lines. Alternatively, the utility could reduce spinning reserves (typically 3 to 7 percent of generating capacity) and rely on selective rapid shedding of loads. Response time requirements here are more stringent — typically about 20 seconds, sometimes much less. Users would contract with the utility to permit interruption of some loads (typically hot water heaters, irrigation pumps, refrigerators) in exchange for lower electricity rates for the interruptible portion of their power use. Presently only large industrial customers have interruptible power tariffs. Florida Power and Light relies on rapid load shedding for some of its "spinning reserve".

- **End-use energy usage information gathering** — Building energy management and control systems could collect and transmit to the utility detailed information on end-use energy consumption along with temperature measurements and thermostat settings. Such information could be used for improving utility load forecasting, improving building energy models, analysis of building energy efficiency, diagnosis of building HVAC problems, and utility provision of energy services.

  Experience with French building energy management control system (EMCS) installations in public buildings (offices, schools) indicates that energy efficiency improvements of at least 10 percent are obtainable from detailed (5 min interval) monitoring and analysis of building energy usage. For smaller commercial and residential customers (without EMCSs) some of these monitoring functions might be performed by a microprocessor based electricity meter.

- **End use energy consumption estimation via regression analysis** — One application of high bandwidth communications would be to frequently record total energy use and appliance/equipment usage (on/off status). Regression studies could then be used to determine energy consumption of individual appliances and equipment.

- **Utility provision of energy services** — The electrical utility could contract to supply space conditioning (HVAC) and (possibly) lighting services within specified tolerances. The utility would then employ remote building monitoring, thermal storage, and direct control over HVAC equipment to meet target temperature ranges at minimum cost. Conceivably, such energy service operations might be supplied by third party vendors (buying power on the spot market).

Transmission & Distribution Automation

As noted earlier, transmission automation is fairly well developed among electric utilities, whereas distribution automation efforts are more recent. Many of the issues concerning transmission automation are discussed above, under utility control computations. Many of the applications and issues are similar for

transmission and distribution automation. Here the distribution automation applications are emphasized:

- **Intelligent Substation Communications** — Currently emerging technologies include the development of intelligent electrical protection devices at substations. Such systems may require expanded protocols for communication between substation devices and utility energy management systems (SCADA systems) over wide area networks.

- **Outage reporting** — Distribution automation would permit more timely, spatially localized reporting of power outages. Outages would be directly detected and reported without relying on customer complaints.

- **Transmission or distribution fault diagnosis** — Real-time analysis of power system state measurements could be used to diagnose fault locations in the transmission and distribution network. This problem is amenable to the use of model-based diagnosis by expert systems.

- **Power Quality Monitoring** — Voltage deviations and other power quality problems could be detected and corrected. See discussion above of fault diagnosis.

- **Automatic meter reading (AMR)** — Aside from the savings in labor costs due to AMR, there are also advantages in reduced exposure of utility personnel in dangerous neighborhoods.

- **Remote service connection/ disconnection** — Electrical service could be turned on or off remotely, reducing labor costs and improving response time for installing service. This would be particularly useful in settings with high turnover of customers such as rental units near colleges.

- **Theft detection** — Closer monitoring of the distribution system, facilitated by distribution automation should permit increased detection of power theft, presently estimated at about 1 percent of power sales or about $2 billion/year.

- **Emergency response planning and operations** — This is facilitated by improved communications, distribution monitoring, GIS (geographic information systems), and expert systems. Emergency response to both equipment failures and natural disasters (fires, hurricanes, and earthquakes) is important.

- **Remote Process Monitoring** — Video monitoring and recording of events at either power plants or substations is useful for control and post-mortem diagnostics. Automatic processing of acoustic signals and optical spectra are useful for assessing the state of generating equipment and switch gear.

- **Facility Security** — Surveillance of generation, transmission, distribution, and communications facilities is an increasingly important application. Such surveillance applications may require audio and video (i.e., multi-media) communications channels. These applications also require reliable, secure communications channels.

- **Geographic Information System (GIS) Applications** — GIS systems (also known as automated mapping/ facilities management (AM/FM) systems) are used many purposes by electric utilities: emergency response planning and operations, planning the siting of new facilities (generation, transmission, solar, wind, hydroelectric), assessing snow packs for planning hydro-electric operations, local area demand growth forecasting, environmental and operational management of rights-of-way, vegetation management. They are used to link customer information systems, engineering systems, SCADA systems and planning.

- Existing AM/FM systems are typically derived from computer aided design (CAD) systems. Utilities have found such systems not fully adequate for the uses to which they are now being put. Better systems, better

adapted to distributed, peer-to-peer, object-oriented computing, with better facilities for linking to other DBMSs are needed.

Remote Generation Unit Control

Remote operation and control of generating units is desirable to reduce operations personnel costs. Common applications would include control of smaller co-generation facilities. Such applications would employ wideband communications, for remote video monitoring and real-time data transmission protocols.

NII Applications to Utility Industry Transactions

In this section we consider NII applications to utility industry transaction, which primarily involve communications among utilities, utilities and independent power producers, utilities and vendors, utilities and regulatory agencies. Some applications also involve communications with customers.

In contrast to intra-utility, or utility-customer communications based applications described above, which could conceivably rely on different communications protocols for different utilities (albeit with the loss of economies of scale), the applications considered here intrinsically require common communications protocols and perhaps even standardized database schemas to be practical.

Power Marketing

- **Support for real-time spot markets in electrical power** — Such spot markets for power would either be between utilities or between utilities and independent power producers (e.g., solar, wind, or co-generation power plants). Customers who had sold options for interruptible service might cover the options with spot market power purchases. Automated operations of such power markets would reduce transaction costs and permit smaller more frequent transactions.

- **Support for real-time futures markets in power** — The logic here is similar to the logic for spot markets. Futures markets for power delivery, and options (interruptible service) would complement spot markets for power.

- **Support for variable quality levels of electric power** — Customers could purchase different quality electric power as needed. Quality measures include voltage control, harmonics, transients, and interruptions. Often critical industrial (or medical) activities require uninterruptible power - but only when the plant is actually operating. Improved communications would permit customers to tell utilities when they needed higher (or lower) quality power.

- **Support for national power trading** — In addition to local or regional trading in electrical power, one can envision inter-regional (United States, Canada, Mexico) real-time power markets. It is anticipated that this will require increased control and communications capabilities to maintain efficient, safe, stable operations of the transmission lines and inter-connected utility grid. More extensive, real-time markets for electric power are expected to create more volatile arrangements for power delivery and thus increase real-time control system requirements. The control computational issues have been (briefly) described above.

Inter- and Intra-Communications and Transactions

Improvements to inter-utility power trading, power wheeling transactions, inter-connections of transmission grids and power pools will require increased communication between utility control centers. This would be facilitated by standard communications protocols and standardized database schemas.

The NII could be used for environmental reporting to the Environmental Protection Agency and various Air Quality Control Districts.

for emergency response reporting to the Federal Emergency Management Agency (FEMA) and the Nuclear Regulatory Commission (NRC). Utility filings with Public Utilities Commissions (PUCs) could be done over the NII and access to the public provided.

A NII would facilitate remote facilities engineering, service, support by utility equipment vendors. This would entail the use of Electronic Data Interchange (EDI) for commercial transactions and the use of standardized Computer Assisted Logistics Systems for documentation. Security issues would also have to be addressed, lest diagnostic access to utility control systems or equipment become trapdoors for intruder access.

PART IV: How Are We Going to Get There?

Institutional Mechanisms

Requirements for an information infrastructure will be a function of the institutional framework of electric power. Discussions of utility reform have typically envisioned the creation of spot markets for electric power, long term contracts (either fixed price or indexed), options contracts for interruptible service, and futures markets. Various schemes have been proposed to permit independent power producers access to transmission and distribution networks and to charge for transmission services. This is known as retail wheeling.

There has been much discussion of the notion of dismembering existing integrated utilities in favor of separate transmission, distribution, and power generation companies. In England such institutional changes have already been put in place. The United States has also seen the rise of numerous independent power producers (wind powered and co-generation facilities primarily). Many expect that future utility scenarios will see much larger numbers of independent producers dispersed throughout the utility service regions. Similarly, improvements in batteries, flywheels and other energy storage technologies suggest that there will be larger numbers of energy storage facilities available. Disaggregated utilities, real-time power markets, retail power wheeling, and dispersed generation and power storage regimes will have more demanding computational and communication requirements. Furthermore the plethora or organizations will generating increasing demands for standardization of communication and database access protocols.

The information infrastructure requirements for electric utility operation are likely to grow as many of these institutional changes are adopted by new legislation, regulatory policies, technology changes, and competitive pressures. Information infrastructure requirements will also be sensitive to the details of transmission pricing policies. Some policies require significantly more communication, sensors, and computation than others. Given that many commercial, industrial activities are not amenable to interruption on short (15 min) time scales, some have suggested that coarser price adjustments (hourly) set further in advance (24 hours) may achieve most of advantageous attainable with real-time pricing. Further research (both theoretical and empirical) in this matter appears warranted.

Information Infrastructure Issues

Increasingly competitive power markets will place more stringent demands on the supporting information infrastructure, especially in terms of interoperability and security. This section discusses how the information infrastructure should be constructed to support the management of electric power generation, demand, and delivery in light of those demands.

Network Protocols

One issue which will have to be resolved is what protocols are to be used for the data communications networks which will support utility monitoring, control, and utility customer communications. Note that different protocols might be employed for different applications. While present utility practice often includes the use of proprietary protocols over dedicated communications lines, there is increased interest and shift toward standard communications

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protocols. This will be essential for large scale utility-customer communications. EPRI has supported the development of such utility-customer communication protocols. The question of which communication protocols the electric utility industry will use is the subject of considerable contention. The debate focusses mainly on the choice between Open Systems Interconnect (OSI) and Transmission Control Protocol/Internet Protocol (TCP/IP) based protocol suites, and on whether to use industry-specific or generic protocols. The development of a utility network architecture that includes high performance technologies, advanced distributed capabilities, low-latency and real-time data flows, security, authentication, and accounting capabilities is needed to support requirements for management of energy demand, supply, delivery.

Commercial support is a key criterion for the selection of a communications protocol. To what extent are the protocol suites currently and prospectively supported by commercial vendors? The current (or near term) availability of commercial products would reduce the risk and cost to utilities and customers of adopting a particular protocol suite.

The capabilities provided by the protocol are also important, specifically: addressing, bandwidth guarantees, and latency guarantees. Is the address space of the protocol adequate to support the proposed applications — ultimately perhaps serving in excess of 100 million nodes? Is the system for allocating addresses practical in an electrical utility setting? Can the protocol guarantee the bandwidth needed for urgent utility communications? Finally, can the protocol provide suitable latency guarantees for transit times for urgent (especially emergency) utility communications?

The last important criterion for protocol selection is the ability to use heterogeneous telecommunications infrastructures. How adaptable to different telecommunications equipment are the communications protocols? Can they be used over general purpose telecommunications networks? Do they require unique (dedicated) telecommunications networks? How much experience is there with real implementations?

There are several major alternatives discussed below: the TCP/IP protocol suite, the OSI protocol suite, real-time protocols, and hybrid protocol suites.

The **TCP/IP and related protocols** were developed by the Internet (formerly ARPANET) community under U.S. Department of Defense (DOD) and National Science Foundation (NSF) sponsorship. These protocols have a large and rapidly growing base of users and vendor support by both computer system vendors and telecommunications vendors. There is a large body of implementation experience, both in local networks and over diverse telecommunications hardware. The Internet protocols are widely used throughout the U.S. government, university, and commercial sectors.

The **Open Systems Interconnect (OSI) protocol suite** was developed by International Standards Organization (ISO) dominated by European computer systems vendors. There is comparatively (relative to TCP/IP) little commercial use of the transport network level OSI protocols; e.g., CLNP, TP0, TP4.

However, OSI application level protocols have proven more popular. Usage of the OSI X.400 mail protocol is extensive and growing. Usage of the OSI X.500 Directory Service protocol is growing. The Remote Database Access (RDA) and SQL standards offer a solution to the problem of accessing heterogeneous remote relational databases. The RDA standards are specified over OCI protocols; however, using the RFC1006 Internet specification, RDA runs over TCP/IP protocols. NIST is sponsoring an RDA/SQL testbed for demonstration projects in the areas of electronic commerce, health care, digital libraries, and scientific research. In addition, NIST has a Memorandum of Understanding with the Canadian Government, Government Telecommunications and Informatics Services, to further RDA testing and technology validation. The NIST testbed hosts two commercial pre-release products, as well as government-developed prototypes. NIST is

developing testing tools to evaluate conformance and interaoperability of RDA implementations.

Major relational DBMS vendors sell communications software for distributed access to their own SQL databases, as well as gateways to certain other SQL databases. However, none of these products meets the broad public need for nonproprietary access methods.

EPRI has used the OSI protocol suite as the basis of their Utility Communications Architecture. This has been adopted by a number of American and Canadian utilities.

Real-time protocol suites (which would provide guaranteed latency and bandwidth for high priority communications) for deployment in general, heterogeneous telecommunications environments are currently the topic of research. Deployment of Asynchronous Transfer Mode (ATM) infrastructure by the telecommunications and computer companies will speed the development of real-time protocols.

Finally, hybrid protocol suites composed of combinations of the above protocol suites are a possibility.

Note that for large homogeneous classes of customers (urban residential customers) it may be sufficient to multicast a single price (schedule) or global load control command. For example, all hot water heaters with an identifier ending with 9, turn off. Such multicast communications may require different protocols (or protocol features) than peer-to-peer protocols, although they are supported in Internet Protocol (IP) and ATM protocols. Similarly, for many purposes it may be sufficient to aggregate responses (e.g., anticipated power demands, or supplies) to a new price schedule message over large portions of the networks, rather than reporting individual responses (anticipated power demands, or supplies). Such aggregation could conceivably be done within the communications network, reducing the number of messages flowing back to the control center. Similar aggregation strategies are employed in network management systems for large data communications and telecommunications networks.

Multicast messages could conceivably rely on broadcast radio communications (e.g., frequency modulation (FM) subcarrier, cellular radio, radio paging systems) rather than wired communications to individual sites. One problem with broadcasting prices is the possibility of discontinuous demand curves, because customers are likely to use discrete price points (even number of cents per kilowatt-hour (kWh)).

Packet radio has been used in some direct-control and automatic meter reading systems, such as Metricom in Southern California Edison. Recently, it seems to have become the favored communications medium for a number of utilities.

New communications architectures may be hybrids of the above alternatives.

Customer Site Network Protocols

Communication protocols for use within a customer site (residence or commercial building) have recently been the subject of contention. Most automated residences today employ the X-10 protocol, which relies on a frequency modulated power line carrier communications with a simple command protocol. More recently there have been two major new contenders: the CEBus protocol proposed by the Electrical Industry Association, and the LONWORKS protocol developed by Echelon Corporation, Motorola and Toshiba. These new protocols are much more powerful and versatile than X-10. CEBus has lacked an integrated implementation in integrated circuits - relying on vendor software implementation on microcontrollers. There have been some problems with interoperability. Motorola and Toshiba provide integrated circuits which implement the LONWORKS protocol. This offers cheap, interoperable implementations. Both CEBus and LONWORKS will operate over a variety of communications media including twisted pair wires, power lines, radio, infrared, optical fiber, coax, etc.

A third protocol, BACnet (Building Automation and Control Network), is being developed by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) with assistance from NIST (the National Institute of Standards and Technology). The BACnet protocol also runs across a variety of media. It is targeted primarily at HVAC (heating, ventilating and air conditioning) and lighting controls for commercial buildings. BACnet protocol specification, standardization and adoption has (thus far) trailed CEBus and LONWORKS.

Communications Media

Utilities (electric, gas, water) have made increasing use of radio frequency wireless communications systems for automatic meter reading, and have sought RF spectrum allocations for this purpose. The economic logic here is that wireless systems require less investment in infrastructure. However, RF spectrum is a finite and increasingly important resource. Arguably, one might wish to consider reserving (or at least favor) use of the RF spectrum for applications, e.g., mobile phones, which require wireless communications. The deployment of the NII to households would obviate the need for the use of RF spectrum for this purpose.

At present utilities employ (or are testing) a wide variety of media for utility customer communications: fiber optics, standard phone lines, UHF/VHF radio, long haul power line carrier, short haul power line carrier, coaxial cable, and even satellite communications for remote areas. At present phone lines, and power line carrier are the most heavily used media.

Distributed Systems Architecture

Distributed systems architectures (DSA) are concerned with establishing a framework and the rules for coordinating the harmonious operation of all the components of a distributed system. In particular, a DSA must provide for building and operating distributed applications. For energy supply and demand management, DSAs must provide for distributed intra-utility, inter-utility, and utility-customer applications. The Open Software Foundation's (OSF) Distributed Computing Environment (DCE) and the Object Management Group's (OMG) Common Object Request Broker are DSAs which provide the features typical of modern DSAs. These features are:

- **A model of distributed parallel computation** — Most systems today employ explicit message passing models of computation. DCE's model is based on the remote procedure call (RPC) and uses threads to achieve parallelism; CORBA's model is one of cooperating (potentially remote) objects. Both DCE and CORBA are biased toward synchronous operation, but contain features which allow for asynchronous operation.

- **A security model** — A security model provides for controlled access to resources (data) and specifies how data is protected during transmission. This is included in DCE.

- **An authentication model** — Such a model specifies how one authenticates users, and messages, i.e., establishes the identity of users and the origin of messages. The Kerberos authentication model is included in DCE.

- **Naming model** — This is concerned with unambiguously identifying resources in a distributed system, e.g., how names are mapped to addresses, name-address resolution, etc. This is included in DCE.

- **File services** — This is concerned with how remote files are accessed over the network and may include features such as operations on logical volumes, synchronization, replication and protection of resources. The Distributed File System (DFS), based on the Andrew File System, is scheduled for inclusion in DCE this year.

- **Symmetry of computations** — Ideally, both the asymmetric client-server model and the symmetric peer-to-peer model should be supported. DCE is based on an asymmetric

(RPC) model (but with tools for symmetric operation) whereas CORBA is based on a symmetric model (with tools for asymmetric operation).

- **Clock synchronization** — Global synchronization of clocks should be maintained among the distributed nodes. This is part of DCE.

- **Resource discovery** — Processes must be able to find out what resources are available on the network and where they are located. Such a mechanism, the Dynamic Invocation Interface, is part of CORBA.

There is considerable effort in both the research and commercial sectors being addressed to the specification, development, deployment, testing of such distributed system architectures. In addition to the vendor-based OSF and OMG standards efforts there are competing proprietary proposals (e.g., OLE by Microsoft). It would be advantageous if the electric utility industry could avail themselves of a distributed system architecture already under development.

There is also a perceived need to define a utility-customer gateway protocol, so as to decouple the communications and control architecture within a residence/commercial building from the distributed systems architecture employed by the utility.

Database Management

There are already a myriad of databases used in the operation of an electric utility, especially a disaggregated utility. Utilities need to know about their own operations (generation, transmission and distribution), the status of nearby utilities or independent power producers with whom it trades power, and its current and anticipated power demand. Some of these are described below.

These may be classified into databases which describe the physical structure of the utility (engineering drawings), those which describe the electrical structure (schematics), and electrical status of all of the utility equipment, those which describe the thermal status of equipment (e.g., boilers, power lines), those which describe the status of reservoirs, and hydro-power facilities, and those which describe fuel inventories, scheduled maintenance and refueling.

Utilities need to maintain real-time databases of prices for both power generation and transmission services. With increased access to the transmission grid by independent power producers such price (and capacity) databases will grow increasingly voluminous. Utilities also need to maintain databases of the current, anticipated, and historical (for billing) electrical loads. Billing/service status databases are used both for accounting and to dispatch staff to connect/disconnect service.

Real-time weather and hydrological databases are used to forecast loads, plan emergency responses to outages, and constrain generation activities which depend on hydro-power or cooling water. Pollutant databases, encompassing pollutant emission limits (current, forecast, purchasable), and plant pollutant emissions (NO_x, SO_2, particulate, radioactivity, cooling discharge) are used in conjunction with weather databases to plan generation operations which are constrained by air or water pollution regulations.

Maintenance operations require databases which record spare equipment stocks, repair vehicle and crew availabilities and locations. Physical security of the utility plant requires real-time databases of intrusion, fire, and flood detectors.

Typically, even within a single utility, the aforementioned data are maintained in separate databases for real-time electrical status (SCADA systems), equipment and network topology (facilities management database), and the billing, tariff and customer information (business database). Often there will be many more databases, partitioned either functionally, geographically, or institutionally (e.g., independent power producers).

The multiplicity of databases, many of which may be maintained by individual power

generation facilities, industrial users, interconnected utilities, independent power generators or transmission facility operators suggested that utilities confront major problems in the integration of heterogeneous databases. This is currently an active area of development among utilities.

In addition to generic database management systems (DBMS) standards efforts (e.g., SQL and RDA) by vendor groups, national and international bodies there are efforts directed specifically at the standardization of spatial data query. There is an effort (the National Spatial Data Infrastructure program) in the federal government to improve the availability, accuracy, and access to spatial information concerning the United States. Such spatial data is of particular interest to public policy debates, taxation, public administration, and disaster response activities. Utilities are also major users of spatial data, for facilities planning, facilities management, maintenance, and emergency response.

DBMS issues to be addressed include:

- **Choice of data models** — What data model(s) will be used for these databases? relational, network, object-oriented?
- **Query languages** — Will all of the databases support a structural query language?
- **Schema integration (and standardization?)** — How will the various schemas of the individual databases be integrated? Will some or all of the schemas be standardized?
- **Transaction management** — How will transactions affecting multiple databases be coordinated? Will the database systems all support 2-phase commit protocols?
- **Replication** — How will databases be replicated to assure high reliability?
- **Data exchange formats** — In what format(s) will data be exchanged?
- **Real-time data management** — Commercial real-time databases are virtually nonexistent. How will these be designed? Who will implement and support them? (At present two telecommunications equipment vendors, have these under development. Existing power control systems rely on ad hoc software.)
- **Active database management** — Network, price, and load monitoring applications all seem prime candidates for active database management systems, in which state transitions trigger rule invocations to respond to changes in the environment. The specification, design, implementation, and programming of such active DBMSs is currently an active research area, with limited commercial products appearing. Is this a suitable technology for power control systems? Can one reliably program such rule systems for this class of application?

Applications Integration

Standardized applications program interfaces are needed for utility industry inter-operability. Such API's require not only agreement on distributed system architectures and/or database access protocols, but more extensive standardized specifications of database schemas, and operation semantics, e.g., the definition, implementation, and testing of standardized objects and methods similar to efforts currently underway in the healthcare informatics industry. Methods for specifying the interactions between applications are needed. Typically, real-time performance constraints must be met.

Network Administration

Electric utilities operating large telecommunication networks have two network administration problems — the telecommunications network and the power network. The problems are similar and raise the question of whether communications network administration protocols and software systems could be profitably adapted for use in administering the power network.

In either case, the networks envisioned are potentially huge encompassing a number of nodes at least equal to the number of separate residences or perhaps even the number of major appliances (plus electric autos), if each had a separate controller. Since many appliances already include microprocessor controls this quite likely.

Total network sizes for the United States may easily reach into the realm of 100 million to a billion nodes. Even a single utility, such as Pacific Gas & Electric, might have ten million nodes. As the price of microprocessors and power electronics declines, disposable electronic ballasts in compact fluorescent light bulbs are already available. One could even conceive of individually addressable light fixtures (e.g., fluorescent ballasts in office buildings).

Communications Security

The primary concern with respect to communication security for electric utility operation is primarily authentication, rather than privacy (but see below). Authentication issues arise both for enforcement of contractual obligations, prevention of meter tampering (power theft) and, perhaps most importantly, to prevent unauthorized interventions in the operation of the power network; i.e., by terrorists, warring states, criminals, or unscrupulous competitors. Electric utility facilities have been favorite targets for terrorists, rebels, and (most recently) for the United States Air Force in Iraq during the Gulf War.

Thus far, this does not seem to have been a salient concern of utilities, presumably, because many utilities presently rely on private dedicated communications networks. If utilities were to rely on public communications networks, e.g., the Internet, they would be much more exposed to security threats to their communications. Hence, such communications security issues will have to be effectively addressed, if utility usage of public communications networks is to become widely adopted.

Thus, it would be prudent to provide some type of digital signature for at least some of the communications. Digital signatures provide for authentication of communications and nonrepudiation of messages (e.g., contracts). Digital signatures are commercially available, e.g., from RSA Data Security, Inc., but the National Institute of Standards and Technology (NIST) has recently adopted a different digital signature algorithm (the Digital Signature Standard (DSS)). While these issues do not seem unique to electric power utilities, they are essential to the success of the applications discussed here.

Concerns over physical security of utility installations (transmission, generation, distribution) at which utility communications will be co-located has caused some in the electric utility industry to question the practicality of third-party communication vendors.

A related problem concerns the possibility of tampering with the meter to falsify the power usage reports, i.e., theft of electrical power. Improved power distribution automation should facilitate detection of some power diversions. Some means of assuring the integrity of the meter and its software are needed.

Communications privacy for electric power communications traffic would be desirable to prevent exposure of residence occupancy (to burglars) or industrial power usage (to competitors). At present this does not seem a major concern. However, such concerns are likely to grow over time, so that eventually encryption of utility-customer communications may be necessary.

Communications Reliability

Electric utility operations place stringent demands on the reliability of the communications systems. Concern over the reliability of public communications networks has led some electric utilities to build private communications networks. However, public communications networks have been increasing their connectivity (and thus reliability in the face of line and switch failures). Hence, their have been suggestions that commercial communications vendors may be able to offer better (or more inexpensive)

reliability than private utility communications networks. In any case, the ability to use public networks in the event of utility communications network failures would offer improved reliability. Such considerations argue in favor of the use of open standard communications protocols which can operate over public communications networks when expedient.

The most demanding utility communications applications are those relating to active transmission systems controls, e.g., flexible AC transmission systems (FACTS), where remote solid-state switches must be operated within a fraction of a cycle (less than 16 ms). This requires low-latency, high bandwidth, highly reliable and highly secure communications network facilities. Utilities have built their own communications networks because of skepticism that public networks would provide requisite response time, bandwidth, reliability and security.

Weather Telemetry, Forecasts

A major driver for electric power loads is the weather, especially air temperature and humidity. Nearly all utilities in the continental United States have summer peak loads caused by air conditioning loads in response to hot, possibly humid weather. Some electric utilities have winter peaks that may be induced by exceptionally cold weather.

Furthermore, as utilities come to rely more on solar and wind power, detailed forecasting of insolation and wind velocities become increasingly important. Customers who use solar heating (space, or hot water) with electric utility grid backup may present weather dependent loads.

Thermal pollution regulations limit the allowable temperatures in water bodies into which cooling water is discharged. Since this may constrain generator operations, such water temperatures must therefore be monitored. Anticipated air pollutant levels may dictate power dispatching rules favoring the use of cleaner (natural gas vs. coal-fired) power plants.

Finally, utilities need to know ambient air temperatures to correctly model temperature behavior of transmission lines and limit power flows so as to prevent overheating.

Thus, utilities are increasingly concerned with obtaining local weather forecasts. They may also care about weather forecasts for neighboring, inter-connected utilities if they participate in power pools. Hence, weather information and forecasts must be acquired and integrated into the power dispatch planning.

If one is using thermal storage (of either heat or cold) in buildings to reduce peak power demands, then the building energy management and control systems will want to know weather forecasts. Thus, if an exceptionally hot day is anticipated, the building EMCS might cool the building further than normal the night before, to lessen the peak cooling power requirement. Obviously, such strategies constrain the tenant comfort tolerances on building air temperature.

Finally, lighting detection and reporting networks are important to utilities for outage detection and power restoration. The EPRI-sponsored lightning detection network could be ported to the NII.

Research and Development Agenda

Research, development, and demonstration projects will (in many cases) be conducted by collaborations of academic institutions, DOE national laboratories, vendors of power and building energy control systems, utilities, and electrical equipment and appliance manufacturers. This section addresses which of those projects might be appropriate for Federal Government funding, who are the appropriate players, and what each of their roles should be.

Types of Research

The following types of research will be needed to support the evolution of NII applications for electric power supply and demand:

- **Theoretical research** on economic and regulatory policies and their impact (including wholesale power markets,

transmission access and pricing, real-time pricing, distributed renewable power generation, energy storage), computational methods for economic dispatch of power, load analysis, unit commitment, power system security analysis, fault diagnosis, real-time control, etc. Much of this work could be conducted in academia. Institutions such as University of California Berkeley, Cornell, University of Illinois, University of Wisconsin, Harvard, and others have established some expertise in this area. Some research also could be conducted in DOE national laboratories.

- **Simulations, prototype software** — construction of prototype software and simulations to evaluate various policies, control strategies, etc. Simulations could help establish the feasibility of spinning reserve reductions via rapidly interruptible loads. This work could be conducted in academia, DOE national labs, or possibly by power control system vendors.

- **Testbed construction and large scale infrastructure design** — potential role for Bonneville Power Administration, Western Area Power Administration and the Tennessee Valley Authority

- **Prototype development of improved electrical sensors, power control devices and ICs**

- **Standardization and prototype development of variable pricing electricity meters**

- **Standardization and prototype development of intelligent appliance controllers**

- **Demonstration projects: both technology demonstrations and market research demonstrations.** Technology demonstration would demonstrate to utilities and their customers that the technology exists and works reliably. Market research demonstrations would be used to establish price responses of peak power demands, to establish customer demand for priority-of-service, i.e., service reliability. Demonstration projects would likely be conducted by consortia of national labs, power control system and equipment vendors, utilities, and utility customers.

Commercial Office Building Demonstrations

Large commercial customers with existing EMCSs appear to be attractive sites for demonstration projects. These customers have sufficient economic incentives to be interested, and they already have experience with installation and operation of energy management and control systems. The proposed trials may only involve some additional communications equipment and software. It is quite possible that computer systems upgrades may be needed - still a relatively small expense. Many of these EMCSs have energy demand management features which could be combined with real time pricing tariffs and communications protocols.

Attempts to demonstrate the economic viability of augmented thermal storage must confront the substantial equipment expense involved in adding thermal storage facilities to buildings. Hence, it is advantageous to identify commercial buildings which already have the augmented thermal storage facilities for inclusion in demonstration projects.

The U.S. General Services Administration owns and operates large numbers of commercial office buildings in large cities throughout the United States. It is possible that they may be amenable to some of the demonstration projects. It is also possible that DOE national laboratories, with large buildings, may be candidate demonstration sites. Many federally owned buildings have EMCSs which could be adapted to energy demand management and real-time pricing response.

Measurement of Long Run Price Response

A key issue in assessing the potential impact and establishing appropriate design parameters for real-time load management is the estimation of price responses for time-of-use and priority-of-service (interruptible) services.

Typical, short term demonstration projects will generally only establish short run price responses, i.e., those for which changes in electrical demand which can be accomplished by rescheduling (or curtailing) activities which generate power demands, or through other steps which require minimal capital investments.

However, many of the benefits to be obtained from time-of-use or priority-of-service pricing may require significant capital investments, e.g., thermal storage facilities, very efficient appliances and HVAC equipment, smart controllers for buildings or appliances which shift loads to off-peak periods or permit selective interruptibility, better building insulation or thermal design, etc. Furthermore, in many cases the improved capital equipment such as smart or very efficient appliances may not yet be available at reasonable costs. Thus short term demonstration experiments may seriously underestimate long run price responses.

Consider that the widespread adoption of two-tier TOU pricing of electricity in Europe has led to the widespread adoption of appliances (washers, dryers, etc.) with setback timers, which are not available in the United States. Europeans also have purchased large numbers of front-loading washers (much more energy and water efficient) which have only recently become widely available for household use in the United States.

Thus, for the purpose of long run price response estimation, it is important to offer power customers the opportunity to install improved capital equipment at the prices which are expected to exist upon mass production. This would presumably require some sort of subsidies for the design, development, and pilot production of this equipment where it does not yet exist. (DOE's Energy Efficiency program supports both R & D and standards development in this area.) Furthermore, most consumers only replace capital equipment (appliances) upon failure, or moving residences. Thus, evidence of long run price response of power demand due to acquisition of improved appliances and air conditioning equipment is likely to accumulate slowly as appliances and HVAC equipment fails and is replaced.

To accurately understand the long run price responses due to changes in building designs, the proposed pricing policies (and improved capital equipment) would have to be available at the time of building design, and equipment specification.

All of this suggests that experiments to accurately estimate long run price responses will probably be larger, more difficult and more expensive than simply installing better telecommunications and metering devices in a small number of households or buildings.

Experimental Design

The naive approach to estimating the impact of NII/RTP on electricity demand is to select a residential neighborhood, install the improved communications and real-time pricing tariffs and compute the difference between before and after peak and aggregate electric consumption. National estimates are then obtained by linear extrapolation to the entire population of residences.

Such an approach is prone to errors as we have seen earlier (in the Section on Direct Economic Impacts). First, before and after measurements of demand can be affected by confounding variables such as the weather, economic conditions, the adoption of more efficient appliances, etc. Two approaches exist to control for such confounding effects. One way is to estimate regression equations which incorporate the effects of the confounding variables. Separate equations can be estimated for both conventional and the experimental regimes. Note that this requires that the investigator specify the parametric form of the dependence of demand on the confounding variables.

Another alternative, which does not require parametric models, is to use matched pair sampling of similar pairs of residences, and then randomly assign one residence of each pair to the experimental regime. The effects of the experimental program can be estimated from the differences between the matched pairs of residences. Such matched pairs sampling readily permit us to remove the effects of

weather, or universal adoption of more efficient appliance technology.

Extrapolation to the entire United States requires a regression model for confounding variables, and knowledge of their distribution over the entire United States (e.g., by national samples). Alternatively, stratified samples of residences (e.g., on residence type, size, age, household size and income, geographic region) could be used and then linearly scaled to the entire United States population. As we have seen, extrapolating from a small homogeneous residential neighborhood to the entire United States will not produce accurate results. Finally, in estimating the impact on aggregate peak loads, one must account for the covariance (or lack thereof) of peak electric demands (e.g., due to weather) over a utility service region.

Similar considerations apply to estimation of the impact of NII/RTP on commercial sector demand. A corollary of these concerns over experimental design is that more detailed surveys of national residential and commercial energy use will be required to establish the basis for extrapolation.

Estimation of Long-run Price Responses

As noted earlier, estimation of long term price responses for peak power demand is particularly difficult, in part because it may require the availability novel capital equipment at mass production prices, and in part because capital equipment decisions are usually made slowly, often only made when existing equipment fails, consumers move or remodel. Thus effective demonstration projects may require the provision of subsidized smart, efficient appliances. This may be problematic both in terms of cost, and the ability to provide a sufficient selection of appliance models.

Experiments in assessing long run price responses might be conducted via conditional sampling - enlisting the assistance of appliance vendors, building and remodeling contractors in a city to present consumers who were replacing appliances, remodeling or building with the option to participate in the experimental program by possibly purchasing experimental appliances, etc., and obtaining time-of-use, real-time, or service priority-based electricity tariffs. Given estimates of rates of appliance replacement, remodeling, and construction, the decisions of those subjects in the experiment could be extrapolated to estimate aggregate long run price responses. The advantage of such an approach is that installation of communications and advanced metering devices would only be required of those households which were replacing some of their appliances.

An alternative approach to estimating long run price responses in the commercial and industrial sectors are engineering economic analyses. The idea would be taken to collect data on a sample of the commercial (and perhaps industrial) building inventory — building size, shape, orientation, HVAC equipment, sensors, control systems, thermostat settings, lighting equipment and operations, weather patterns. Given putative price schedules (either TOU or RTP), interest rates, and (possibly) rental market demand forecasts, one might then employ engineering models of equipment and building performance to calculate alternative heating/cooling schedules, or capital equipment upgrades which would minimize the expected combined energy and capital costs of operating the buildings. With a properly designed sample, such calculations could be extrapolated to the entire U.S. economy. Such computations assume that the building operators are fully informed (about the costs of alternative technologies) and rational. Such assumptions are more appropriate to the operators of large buildings than individuals. Even so, one must consider the impact of rental/lease contracts in which responsibilities for electric power costs and HVAC and lighting equipment diverge.

Similar sorts of engineering economic analyses could be used to attempt to forecast changes in the design and equipment of new commercial construction. The combined electric power demands of existing commercial building inventories and projected new construction could thus be used to construct aggregate power demand estimates, and thus determine projected savings.

Regulatory and Standards Issues to be Addressed

- What regulatory policies and standards would be most effective in promoting the adoption of these technologies should they be undertaken? in power system regulatory policies? in communications, meter standards? in electrical and HVAC equipment and appliance standards? in building codes and mortgage regulations? in software and communications standards? and in standardized power contracts?

- What organizations (public and private) are most appropriate and effective for the development of standards and regulatory policies? What role should various federal agencies (DOE, EPA, FERC, NSF, NIST) play in this process: funding regulatory studies, writing draft legislation and standards, funding demonstration projects of proposed standards.

- How can electric utilities contribute to achieving universal telecommunications access? Do electric utilities have adequate legal authority to build public telecommunications facilities? Should they?

Conclusions

Improved information infrastructure together with regulatory and pricing reforms will permit more competitive and efficient markets for electric power, improved capital utilization of electrical capital equipment, energy conservation, and reduced operating costs for electric utilities. The savings which will accrue from energy sector applications of the NII could make substantial contributions to the cost of deploying the NII. Electric utilities are potentially major telecommunication vendors.

Institutional regimes can be improved by funding research in pricing, regulatory policy, and control policies to support regulatory reform, and by regulatory reform of pricing and access for electric power generation, transmission, and distribution, and (possibly) permitting electric utility marketing of telecommunication services.

Information infrastructure issues arise from the increased demands for interoperability, security, etc., generated by more competitive power markets and more efficient pricing policies (e.g., variable service level and real-time pricing). The Federal Government can support research into the technical issues. It can also help to promote adoption of suitable communications, database, and equipment standards. Such standards promotion could take the form technical and financial support (e.g., via NIST), by use of federal procurements, national appliance standards and building codes, or various subsidies to encourage early adoption.

In addition to theoretical research and prototype development and testing, federal assistance in the funding, design, conduct and evaluation of substantial demonstration projects would be useful to convince utilities, appliance vendors, public utility commissions, and consumers of the availability, reliability, and economic utility of these technologies. Carefully designed studies of the economic, energy, and environmental impacts of demonstration projects are needed to support national impact projections which will shape national policymaking.

Finally, one must anticipate that more competitive power markets, real-time pricing, and role of electric energy applications in underwriting the NII may have some adverse impacts on income distribution, differential accessibility of the NII in poorer neighborhoods, and increased resistance and evasion by electric utilities to environmental regulations. Compensatory government actions may be necessary.

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Improving Transportation: The National Information Infrastructure and Intelligent Transportation Systems

DRAFT FOR PUBLIC COMMENT

"It is the policy of the United States to develop a National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the Nation to compete in the global economy, and will move people and goods in an energy efficient manner.

The National Intermodal Transportation System shall consist of all forms of transportation in a unified, interconnected manner, including the transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the Nation's preeminent position in international commerce."

Intermodal Surface Transportation Efficiency Act of 1991

PART I: What Is the Application Arena?

The U.S. transportation system is among the most extensive in the world. It is a massive enterprise that accounts for over 15 percent of the Gross Domestic Product. The physical transportation system infrastructure is valued at $2.4 trillion and includes nearly 6,437,200 kilometers (km) of highways and roads; more than 402,325 km of rail and rapid transit lines; 305,767 km of petroleum pipelines; 41,842 km of navigable waterways; and over 2,000 commercial airports, seaports, and intermodal terminals. This infrastructure is used by some 200 million cars, trucks, and buses; over a million trolleys, locomotives, and passenger and freight railcars; some 35,000 commercial vessels, ferries, and barges; and 300,000 civil aircraft (DoT, 1994).

Impressive as it is, the U.S. transportation system faces significant challenges in serving the future mobility needs of the nation that are closely linked to America's economic vitality and competitiveness. The competitive forces unleashed by transportation deregulation over the past two decades, coupled with tight fiscal constraints and growing environmental impact awareness and sensitivity, have created strong incentives for lean and efficient transportation rather than system expansion. Enhancing the performance of the existing transportation system infrastructure increasingly is viewed as the preferred option, and, at times, the only one when physical expansion is impractical.

Overlaying the existing transportation infrastructure with a complementary information infrastructure could dramatically improve transportation service, cost, safety, and efficiency, while lessening adverse environmental impacts. Emerging electronic information systems and communication technologies are providing new ways for operators to improve transportation system performance, and enabling travelers and shippers to make informed transportation choices. Secretary of Transportation Federico

Peña envisions a society infused with information systems that will connect all modes of transportation into a cohesive system and also link transportation as a vital part of the National Information Infrastructure (NII). (Peña, 1994)

Potential transportation applications of the NII have several intrinsic distinctions. Often dispersed, "real-time" information elements and potentially vast mobile user populations are involved. Static information resources that characterize various location, status, condition, capacity, safety, and performance attributes of the nation's vast transportation enterprise constitute extremely large data sets. And last but not least, safety critical command-and-control applications, such as in air traffic control must be ultra reliable and secure to be trustworthy.

National and Public Benefits

The majority of national and public benefits of transportation applications of the NII will be manifested in terms of safety and efficiency. Future transportation visions foresee a host of potential applications for the emerging NII that could provide vastly enhanced access to vital information when and where it is needed to support informed choices.

U.S. transportation systems lead the world in terms of safety. Yet transportation remains a significant health hazard, especially for young adults and children. Each year, more than 40,000 persons are fatally injured and another 5 million suffer lesser injuries in traffic accidents, at an additional annual cost of $70 billion to the nation's economy. Nearly $15 billion is spent annually on health care related to transportation accidents. (DoT, 1994)

Congestion plagues the transportation system, particularly in urban areas and along major intercity traffic corridors. Seventy percent of urban freeways are severely congested during rush hours; 23 major airports experience over 20,000 hours of flight delay each year; and both passenger and freight trains are coping with excessive demand. The annual cost of congestion to the nation in lost productivity alone is over $100 billion, exclusive of the costs of wasted fuel and environmental damage. Beyond its direct impact on regional economic activities, congestion also limits opportunities for U.S. industries to access and serve national and international markets. (DoT, 1994)

NII applications are envisioned that could significantly enhance transportation efficiency; particularly for public transit, intercity rail, and commercial motor carriers and airline services. Collectively, these reflect a trend toward an "intelligent" transportation system.

An "intelligent" transportation system is one that provides the information needed to enable informed decisions by transportation planners, managers, users, and operators alike. It is one in which system operators and users share information and cooperate to enhance system performance, efficiency, capability, and user satisfaction. It is one in which mobility is enhanced by information systems that help make affordable transportation accessible to all Americans, especially the elderly and the mobility impaired. It is one that provides efficient transportation of people and goods, with the attendant environmental and energy conservation benefits.

Envisioned "intelligent" transportation system innovations include:

- Traffic management systems that monitor traffic situations, detect incidents, meter traffic flows, and issue "travel-cast" information based on actual conditions rather than on forecasts based on static schedules and/or historical patterns.

- Traveler information systems linked to multiple information sources (TV, radio, personal computers, information kiosks, telephones, hand-held devices, and others) that provide information needed to make informed choices about whether to travel, when to go, and traffic and weather status information, as well as transportation alternatives, terminals and access points, schedules, costs, and timetables.

- Fleet management information systems that enable motor freight, emergency vehicle, public transit, airlines, maritime operators, and hazardous material transporters to continuously track, monitor status, and communicate with mobile fleets as needed to provide responsive customer services.

- On-board electronic navigation and guidance devices that can receive radionavigation signals and supplemental information needed to determine efficient routes, safeguard against vehicle collisions, and assist in guiding vehicles along intended pathways or trajectories.

In addition to real-time data for operational decisions, "intelligent" transportation systems will provide information needed to facilitate and enhance strategic policy decisions. A new generation of "smart" infrastructure that can monitor traffic volumes, loads, accidents, and physical conditions is assumed. Examples of systems include those that provide information to:

- Enable safety officials to sort through massive databases and spot safety risks or incipient hazards.

- Enable transportation decision makers to effectively plan long-range transportation system infrastructure improvements and to formulate sound transportation policies.

- Implement various management systems to track and improve public sector pavement, bridge, safety, congestion, public transit, and intermodal system performance.

As discussed elsewhere in this document, telecommuting is a growing trend that holds significant implications for transportation. Although addressed in another application paper, the potential for telecommuting to impact future travel patterns and traffic conditions is acknowledged. As is the ability of intelligent transportation systems to enable workers to choose whether to venture to the office or to telecommute from home on particular days.

Public and Private Roles

Transportation in the United States involves both public sector and private industry participants. With some exceptions, the public sector provides transportation infrastructure, whereas private parties control the production and operation of vehicles and transportation services. Exceptions include public transit operations, which have shifted predominantly to the public domain, and railroads and pipelines, which have a tradition of private ownership and operation.

Developing and deploying NII transportation applications will entail unprecedented levels of cooperation among public sector agencies and private organizations. The Federal Government has an important, but not the only, role to play. It will be necessary to achieve the cooperation of transportation system users: Federal, State, and local Government agencies; research and academic institutions; and private sector transportation providers.

The U.S. Department of Transportation (DoT) is committed to providing national leadership in developing transportation applications of the NII. It plans to work with other federal agencies and other public and private stakeholders to achieve consensus on a national system framework for "intelligent" transportation systems. It will foster unifying system standards to ensure compatibility and appropriate interfaces among transportation applications and with other NII applications. The DoT also intends to fund research, development, demonstrations, field operational tests, and deployments of IVHS and other information and communications applications of the NII. (DoT, 1992)

The federal effort is to be complemented by state and local government efforts to assess needs and plan implementation strategies, and by private sector initiatives to identify and pursue commercial opportunities. The market opportunities associated with various emerging intelligent transportation systems will be upwards of $200 billion through 2011, based solely on private (85%) and public sector (15%) expenditures for highway and transit applications. (IVHS America, 1992)

PART II: Where Are We Now?

Currently, the transportation information infrastructure varies widely. Aviation information systems are at the forefront of modern technology, yet in comparison other forms of transportation lag behind.

United States aviation information and communication technology is unsurpassed. Air traffic is continuously monitored and traffic situation and weather condition information is provided to aviators before they take-off, during flight, and as they land. Flight plans and status are filed and amended electronically. Composite air traffic situation information is generated by the FAA and shared with airlines on a minute-to-minute basis. Flight arrival and departure information is readily available via various communications channels. U.S. airline computer reservation and scheduling systems are legendary in terms of size, complexity, and effectiveness as marketing weapons.

The advantages of advanced information technologies recently have begun to be actively sought in other transportation domains, most notably by overnight delivery services which are able to inform shippers and receivers as to where shipments are and when deliveries have been made. As in overnight package delivery, traditional motor, rail, and marine freight companies are applying information and communication technologies to enhance transportation operations and to provide customers with information about the status of shipments in transit. Intermodal shipping companies also are developing information technology to afford customers with unified marine, rail, and truck shipment tracking services to complement the "just-in-time" logistics requirements associated with "lean manufacturing" in which information on materiel in transit is used to minimize on-site inventories.

However, surface transportation information infrastructure within the public domain is sparse and often dated. Federal cutbacks in transportation research and development in the 1980's, coupled with priority needs to maintain and rehabilitate existing facilities, resulted in few noticeable advances during that period. European and Japanese advanced vehicle and highway systems initiatives begun during the late 1980's served to rekindle public and private U.S. interest in advanced surface transportation systems.

With few exceptions highway travelers and public transit users have limited access to current information about travel options, costs, schedule / travel time, and traffic conditions. Knowledge is gained through static signs and schedules, radio broadcasts, Citizens Band radio chatter, and through encounters with travel delays and missed connections due to various conditions, often known to authorities yet not publicly communicated. Notably, the growth of mobile cellular telephony has given rise to rapid detection and reporting of traffic incidents by motorists or others at the scene, yet outlets for dispensing this information are relatively unchanged.

Federal Goals

Under the leadership of Secretary Federico Peña the DoT has established a number of strategic goals to accelerate innovative transportation applications of advanced information and communication technologies. The overall vision is for greater situational awareness among transportation system users regarding travel conditions and options, both before and while traveling. The vision also includes the ability to communicate with vehicles, people and goods anywhere within the transportation system, leading to enhanced productivity and user satisfaction.

Strategic DoT goals and objectives include:

- Accelerating applications research and development. In addition to sustaining world leadership in aviation-related information technologies, applications of information systems and communications technology in surface transportation are being accelerated through the Intelligent Vehicle-Highway Systems (IVHS) program.

- Fostering compatibility and interoperability. A systems architecture framework is being developed for IVHS, including applicable linkages to aviation, marine, and pipeline applications, as well as the overall NII.

- Establishing transportation-specific NII components. The DoT is working with other agencies and user groups to address the particular information and communications needs of transportation applications. Efforts are underway to determine suitable means for augmenting the accuracy and integrity of GPS (global positioning system) radio-navigation services. A radio spectrum allocation has been obtained for IVHS purposes.

- Establishing navigation and positioning services. The DoT is working with other federal agencies and user groups to encourage widespread use of the Global Positioning Service (GPS). For applications requiring additional accuracy or integrity (i.e., validation signals), GPS augmentation systems are being advanced by the U.S. Coast Guard and the Federal Aviation Administration (FAA). Augmented GPS services are planned for the mid-1990's.

- Conducting field trials, and technology demonstrations. As a part of its renewed research and technology emphasis, the DoT is actively sponsoring field trials and technology demonstrations in operational settings. From aviation weather information systems to harbor traffic management systems to highway safety and warning systems to public transit information kiosks, DoT agencies are seeking out new and improved ways to provide safe and efficient transportation services.

- Stimulating private initiatives. In partnership with the Advanced Research Projects Agency, NASA, the National Science Foundation, the Department of Commerce, and the Department of Energy, the DoT is participating in the Technology Reinvestment Project (TRP). Likewise, DoT is collaborating with the Department of Commerce in its Advanced Technology Program.

  Four transportation related projects have been awarded within the TRP Information Infrastructure focus area. These focus on: automated train control, computer vision for toll enforcement, wireless sensors, and communications systems for mobile applications.

  The ATP program has funded projects to advance foundational technologies needed for transportation applications. These include projects in: fiber-optic computer communications, flat panel displays, digital video and image processing technologies, wireless communications, "talk-touch-type" user interfaces, and autonomous vehicle navigation.

National Science and Technology Council

Through the Information Infrastructure for Transportation Subcommittee of the National Science and Technology Council Interagency Coordinating Committee on Transportation R&D, the DoT is promoting the coordination of transportation-related research throughout the Federal Government. In its initial April 1994 report the Interagency Coordinating Committee determined that there is a pressing need for R&D leading to an information infrastructure that overlays the transportation infrastructure. The committee, and the DoT, believe that overlaying the transportation infrastructure with a information infrastructure may hold greater promise for improving safety, capacity, and efficiency than reconstruction or renewal of physical facilities and infrastructure. Top priorities identified in the Committee report are:

- Transportation applications of advanced information, communication, and navigation technologies.

- Intelligent Vehicle Highway System (IVHS) technologies and services.

- Next-generation air traffic control.
- Improved weather forecasting and reporting.

The DoT is providing technical leadership and guidance to ensure national compatibility among transportation applications of the NII. It also is working with other federal agencies, such as the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC), to ensure suitable spectrum allocations and frequencies are available for transportation applications, nationwide.

Status of NII Applications

Transportation applications of the NII abound. Opportunities for intelligent transportation systems are especially attractive. These involve the use of information technologies to sense current traffic conditions, spot incidents, and provide transportation system operators and users with information needed to act responsibly given prevailing circumstances. A number of such applications are outlined below.

Intelligent Vehicle Highway Systems (IVHS)

IVHS apply information and communication technologies to surface transportation needs. The IVHS program focuses on developing and deploying user services that are defined based on the benefits that users will receive. Various user services are intended to improve safety, enhance mobility, and reduce environmental impacts. IVHS concepts for creating safer, better informed travelers include the following:

- Pre-trip travel information systems that will allow travelers to access and choose from available transportation options. Advanced traveler information systems will provide information on public transit routes and schedules, traffic conditions, and weather information to people at home, work, and other sites where trips originate. With such information, travelers can select the best departure time, transportation mode, and route.
- En-route information services that provide driver advisories about traffic conditions, accidents, and weather conditions. These include in-vehicle signing systems that will provide drivers with information similar to that provided by roadside signs today.
- Route guidance, navigation and information systems that provide simple instructions on how to reach desired destinations and/or traveler services along the way.
- Traveler services information systems that provide information on travel services and facilities such as the location, operating hours, and availability of lodging, food, fuel, parking, motor vehicle repair, towing, medical, and emergency services.
- Ride-matching and reservation information services that provide real-time ride-matching information to users in their homes, offices, or other locations.
- Incident management information systems that enables officials to quickly identify and respond to traffic incidents to minimize any associated congestion and delay.
- Fleet management systems that provide two-way mobile communication between vehicles and dispatch centers, enabling the status of a vehicle, its cargo, and its operator to be monitored remotely.
- Electronic credentials that permit motor carriers to purchase annual or temporary operating credentials via computer link, eliminating burdensome paperwork and reducing processing time for states and trucking firms alike.

About 60 cooperative field tests of IVHS services are being planned or conducted in various parts of the country. Field test proposals are solicited by the Federal Highway Administration (FHWA) on behalf of participating DoT agencies. Several illustrative examples are outlined below, along with a complementary effort that has arisen outside of the federal IVHS program. A list of

field tests is published annually. (DoT, March 1994).

- TraveTek was an initial project sponsored by the FHWA. Through the cooperation of the City of Orlando, the Florida Department of Transportation, General Motors, the American Automobile Association, FHWA, and the National Highway Traffic Safety Administration, people living in or visiting the Orlando area had the opportunity to rent cars equipped to provide information on routing, traffic conditions, and hotels, restaurants and other travel destinations in the area.

- In Boston, a Smart Traveler field test was undertaken to assess public acceptance and the potential impacts of providing current information on highway and transit travel conditions via telephone. Through the cooperative efforts of the FHWA, the Massachusetts Highway Department and local radio and television stations which helped promote public awareness of the trial service, SmartRoute Systems was able to demonstrate an ability to influence traveler decisions through its innovative audiotext system that provides up-to-the-minute information on specific travel routes. The 1993 test generated a 97% user satisfaction rating and was extended for further evaluation. Smart Traveler can be accessed by calling (617) 374-1234.

- The "Advantage I-75" field test provides a testbed for commercial vehicle operations technologies that can increase efficiency and improve safety. Trucks equipped with transponders can use electronic credentials to travel on any segment along the 3,540 km length of the Interstate 75 Ontario to Florida corridor at mainline speeds, with no more than one stop at any truck weight or regulatory enforcement station along the way.

- Separate from the federal IVHS program, Maxwell Laboratories and the California Department of Transportation (Caltrans) have teamed to provide the public an opportunity to access real-time traffic information via the Internet World Wide Web. Up-to-the-minute freeway speeds, accident reports and construction closures are provided both as a graphical display superimposed on a San Diego freeway map and as a text listing. The display depicts decreasing congestion severity in red, yellow, and green. Instructions are available via Internetmail request at: traffic_info@scubed.com. (S-Cubed, 1994)

Advanced Public Transportation Systems

Public transit networks have the potential to benefit greatly from the use of information technologies. As part of the DoT IVHS initiative, the Federal Transit Administration seeks to improve public transportation through the use of advanced information systems and communications technology. Application concepts include:

- Smart vehicle technology that integrates vehicle-based systems to improve fleet planning, scheduling, and operations. By using real-time information collected from automatic vehicle location (AVL), toll collection, passenger counting, load sensing, and on-board vehicle diagnostic sensors linked to a control center via communications systems, smart vehicles will be able to provide accurate, real-time vehicle information to both operations personnel and customers. Field tests are currently under way at Baltimore, Portland, Denver, and Dallas using vehicle location technologies.

- Smart traveler technology for providing travel information to customers before they make their travel decisions. Smart traveler technology will provide real-time travel information through the use of technologies such as smart cards, digital maps, information kiosks, microcomputers, cable television, and audiotext systems. With access to information on traffic congestion, route scheduling, and mode availability, customers will be better able to choose travel situations best suited to their needs. Field tests are under way in Texas, Washington, California, Minnesota, North Carolina, and Virginia to evaluate the use of traveler information systems.

- Smart intermodal systems for creating a virtual intermodal transportation system by linking different transportation modes into an integrated information network. By sharing traffic, scheduling, fare, and payment data, independent agencies can coordinate and integrate their systems to create an overall transportation information management system. Customers can then use this system to conveniently access travel information from one central source. Field operational tests are being conducted in Michigan, Illinois, and California to assess the use of integrated information systems such as central travel information and computer-assisted fleet dispatch and control.

National Airspace Applications

Air traffic management has evolved over more than half a century and represents the enabling infrastructure for today's air commerce. As the next century nears, there are significant advancements being implemented based on the viability of advanced technologies for information processing, communications, and navigation—to a large extent enabled by satellites. Applications of information technologies that are foreseen for aviation include:

- A significant increase in "direct" flight paths, enabled by wide area surveillance with automated conflict resolution.

- New approaches to the collection and fusion of weather data from many sources, including widely dispersed surface-based and mobile sensors on-board aircraft.

- Timely transmission of enhanced weather information to traffic control centers and to pilots in the cockpit.

- Improved processing and distribution of flight arrival and departure data when flights are delayed due to weather or other factors. The availability of this data will aid travelers in coping with delays.

- Access to regulatory information, including graphical data, could be facilitated through the NII. A safe, fast, and efficient aviation system is due in part to the existence of and adherence to a vast set of operating regulations. Increasingly, these are being made available in electronic form to foster user awareness and compliance.

- A national capability for transmitting data on aircraft conditions, maintenance needs, and problems to awaiting ground crews is anticipated.

Waterways Management

Waterways management, including marine navigation and vessel traffic services, is a potential NII application area. These services will require an information system architecture that supports highly reliable, real-time, wireless communications. Many opportunities exist:

- A wealth of user information resides in shore-side databases that can be made available to the public. Notices to mariners, electronic charts and their updates, weather, currents, hazards, and situational displays all would benefit from an on-demand capability.

- For vessel traffic services, the maritime counterpart to air traffic control, the NII can provide standardized interfaces and transmission protocols for common use by international and domestic marine carriers. Users must view such NII interfaces as an unobtrusive service for managing maritime traffic in all weather conditions.

- Vessel traffic services can effectively reduce ship collisions, rammings, and groundings in high-density harbors through automated, continuous position reports, with return data communications to the vessel bridge. Current voice capabilities are inadequate. Verification of required vessel operating equipment for port entry can be performed automatically and forwarded to all other possible ports of entry, thereby significantly enhancing port safety.

- Sea lanes can be monitored by automated surveillance from satellite-based position reports. Currently, vessels have no knowledge of the position of other vessels on the high seas until radar contact is made.

Other marine potential applications of the NII include:

- An improved capability for coordinating the emergency response to a marine disaster by having current information on the nature of the spill and available response resources. Oil spill response can greatly benefit from an improved, real-time data system capability.

- United States Coast Guard command-and-control across all its mission areas would be facilitated by a highly reliable information architecture that provides interoperability among Coast Guard and other Government assets. Security and integrity of the information must be preserved to eliminate unfriendly threats aimed at disrupting or infiltrating the information process.

- Enhanced search and rescue missions based on automated, continuous, identified position reports from ships on the high seas. This would ensure the consistency and reliability of voluntary location reports that now are transmitted sporadically via voice communications.

Advanced Train Control Systems

Recent train collisions have put a spotlight on technologies that provide positive train separation. The National Transportation Safety Board believes automated train control systems could avert some of the 200 deadly train collisions each year. (Washington Post, 1994)

Today, train control is provided to varying degrees by the individual railroads; there is no national-level train control similar to aviation's air traffic control. Throughout much of the U.S. trains operate "in the dark." Train status information is usually only available through radio communications between train operators and central control.

Over the past several years, the rail industry has pursued Advanced Train Control Systems (ATCS) that apply digital radio techniques, automated location systems, vehicle sensor systems, and automated control processors to the integrated, centralized control of rail operations. Using satellites or ground navigation and communications to locate trains with extreme precision, dispatchers can control train movement and speed to ensure adequate train separation.

ATCS could benefit railroad transportation in a number of ways. Illustrative benefits are:

- Increased safety, by providing warnings of oncoming trains on the track.

- Enhanced productivity, by increasing rail system throughput without the need for massive infrastructure investment.

- Improved train performance and reduced cycle-time and maintenance costs.

- Elimination of thousands of miles of expensive tower signaling, wiring, and telephones by replacement with radio data links to rail traffic control centers.

Despite these benefits, high costs have hindered the application of ATCS technologies. Before making the decision to invest, railcarriers are now testing ATCS feasibility and evaluating costs.

Under TRP program, the San Francisco Bay Area Rapid Transit District (BART) and a regional technology alliance, made up of Hughes Aircraft and Morrison-Knudsen, will demonstrate an advanced radio-based control system for mass transit trains. The DoT Federal Transit Administration (FTA), along with the Research and Special Programs Administration's (RSPA) Volpe Center will oversee the $39 million program to apply military tracking and communications technology for reducing rail transit headways, increasing capacity and safety, and lowering costs.

Intermodal Transportation

An important application of information technologies is to facilitate seamless intermodal movement of passengers and goods throughout the total transportation system encompassing highway, rail, air, and waterway networks. Key information technologies for intermodal transportation include:

- Smart Card Electronic Payment. Smart cards provide a common electronic payment medium that can be used for all modes and functions such as parking fees, tolls, fares, or congestion pricing.

- Electronic Data Interchange (EDI). EDI standards enable information and data transfers between computer systems used by transportation providers. Intermodal applications of EDI include invoicing and bills of lading, shipping and order taking, electronic load tendering, and personnel assignment.

- Automated Equipment Identification (AEI). AEI involves the use of transponders and tags to identify transportation equipment (railcars, trailers, containers), which can be conveyed electronically to rail carriers, truckers, intermodal marketing agents, shippers, and other parties involved in intermodal activities such as automated customs clearance.

- Automated cargo tracking. Leading firms in the package freight industry are fully automated, such that customers can order pick-ups, produce bar-coded labels, and track progress from their own facilities. For instance, Federal Express Powership™ cargo tracking system software, enables customers to obtain status updates on their shipments via computer link.

- Fuel Management Systems. These monitor fuel consumption and inventories and conduct daily reconciliations that can signal leaks in fuel storage systems or excessive vehicle fuel consumption.

Presently, the seven largest ocean carriers are working toward a common system that can be used to expedite interline and intermodal transfers. Similarly, railroads are pursuing EDI and related technologies that can enable electronic exchange of shipment and billing information among some 500 railroads in the United States and corresponding groups of railroads in Canada and Mexico.

Transportation Security

Cargo theft is estimated by the National Cargo Security Council to cost $10 billion per year. Today, information developed on cargo theft around the country is collected and retained locally. Despite huge losses, there is no nationwide system for reporting cargo theft and sharing information among law enforcement agencies and industry.

New tracking and surveillance technologies can also be used for the security of the traveling public. A tiny alerting device can be given a person entering a large parking lot with which he or she can instantly alert a mobile security vehicle of a problem. Technology is being developed by industry that will enable the alerting device to be "pinpointed," a video camera targeted to photograph the scene, and near-by security forces to be alerted to the situation. Advanced security technologies can be applied to ensure the safety and security of public transportation patrons as well.

Defense Transportation and Logistics

Closely linked to civilian transportation uses of the NII are many current and planned defense transportation and logistics applications. A recent study postulated the structure of a 21st-Century transportation and logistics information infrastructure for the military, as part of an overall Defense Information Infrastructure (DII).

A compelling desire of the military is to make efficient use of scarce transportation assets. To be effective, the military must operate efficiently in peacetime, yet be able to expand its peacetime transportation and logistics capabilities to meet a variety of possible crisis

levels. Thus, the military relies extensively on commercial transportation systems in times of peace and crisis. To do so, it must be able to command-and-control both its military and commercial transportation assets in a unified manner. This requires information on the status and capacity of military and commercial transportation assets.

The defense transportation community and the DoT are working together with the commercial transportation industry to address military transportation applications of the NII. The DoT Volpe National Transportation Systems Center is the Executive Agent for the National Defense Transportation Association's Technology Committee that is to facilitate unified in-transit visibility capabilities, information systems interfaces and advanced transportation systems technology concepts.

As envisioned, the DII will improve current military transportation and logistics. It also will make possible new functions that currently are so difficult, expensive, or time-consuming, they remain virtually nonexistent. Examples include:

- Faster deployment planning, using up-to-date movement requirements and transport availability data. The presence of weather and geographical data servers within the DII will enable the generation of realistic plans.
- The ability to track transportation assets, troops and cargo worldwide. Satellite navigation and communication technology is making global "in-transit-visibility" a reality for an increasing portion of the military and civilian transport fleets.
- On-line access to information, such as weather, geographical charts, political status, and worldwide location of U.S. and allied transportation and logistics assets.

Transportation Information Resources

Transportation information used for policy analysis, planning, and business management constitutes a significant and important body of data. The mission of the recently established DoT Bureau of Transportation Statistics (BTS) is to ensure that information for making informed transportation decisions is gathered, processed, and made publicly available.

These information resources are essential for making decisions on a variety of topics ranging from infrastructure investments to safety regulations. Moreover, these resources are vital to the private industries that manufacture vehicles, build infrastructure, and market transportation services. Both the private and public sectors are moving rapidly to collect, store, and communicate "static" transportation information in digital form—not only to reduce costs, but to improve the quality of data needed for decisions.

A significant amount of the information used by Metropolitan Planning Organizations, port authorities, transit agencies, and state transportation planners is derived locally and not widely disseminated. However, the DoT works closely with the private sector and with state and local governments, and is a provider, as well as a user, of transportation information.

The BTS has a program to evaluate the state of transportation statistics and to identify improvements needed to the underlying data and methods. The BTS maintains the *Directory of Data Sources* and annually publishes *Transportation Statistics*. These include descriptions of data acquired by DoT agencies and priority areas needing BTS attention. Many BTS information resources are available on CD-ROM disks.

Some of the major purposes, types of data, most frequent users, and examples of current information-handling methods are described below.

Infrastructure Investment Planning

- Highway and transit programs require extensive planning and coordination. The Federal Highway Administration maintains over 30 databases on highway inventory, conditions, and performance. Basic performance data from a number of these is

essential for developing highway and transit improvement programs, and, for most metropolitan areas, air quality and congestion constraints are adding considerably to the information needed. Programs and data to support decisions at the local level are not likely to emerge from commercial software firms; thus, progress may depend on federal support.

- The national aviation system is operated by the FAA, by airports, and by the airlines and aviation service companies. Both public and private property-owners are highly dependent on about 40 aviation activity databases maintained by the FAA with inputs from its own data systems as well as from airports and airlines. Air travel route and growth patterns have had a significant impact on runway additions, hub terminals and maintenance facility investments, and airways services.

- Rail system modernization is slightly less dependent on public statistics because the infrastructure is largely owned by the railroads. However, the need for better and more up-to-date statistics on the national rail system and commodity flows has increased as the railroads adapt to provide intermodal services. The Federal Railroad Administration (FRA) plans to create a geographic information systems that documents characteristics of the national railroad infrastructure.

- Port and intermodal transfer facility developments are funded both by port authorities and tenant ocean carrier and intermodal companies, as well as a wide variety of freight consolidators and other private firms that serve international trade. The Maritime Administration (MARAD) maintains databases on merchant ships, commerce, port capabilities, intermodal equipment, and government shipments. This information consists of data collected by the U.S. Army Corps of Engineers, the Census Bureau, and MARAD itself.

Safety and Security

Facility and equipment safety certifications and regulations are prepared by most U.S. DoT agencies. Data collected or furnished to the Department is used internally for analysis of potential regulations. Data that is not proprietary or would not compromise security interests is made available for further analysis to aircraft and automobile manufacturers, safety inspectors, law enforcement agencies, carriers, and the general public.

Various DoT agencies maintain over 50 safety-related and security-related databases, covering aviation, rail, transit, highway, pipeline, and marine transportation, and the transportation of hazardous materials. For example:

- The Federal Aviation Administration (FAA) distributes safety and security information to airports, flight service stations, medical examiners, pilots, and aircraft owners using electronic bulletin boards, local- and wide-area networks, dial-up and dedicated lines, electronic mail, and printed materials. Although much of this information is already in electronic form, the NII offers the potential to provide more people with ready access to safety critical information.

- The Federal Railroad Administration (FRA) is researching ways to automate track structure surveys used for safety and maintenance planning purposes. These automated methods would improve safety by detecting imminent hazards, while facilitating more efficient planning of railroad maintenance activities.

- The National Highway Traffic Safety Administration (NHTSA) maintains 11 databases containing over 6 million new records each year. Text, data, and video information on crash test results and motor vehicle safety could be provided to researchers, the motor vehicle industry, educational institutions, and

the public. In the long term, the NHTSA plans to form working relationships with researchers and industry and to establish data links with law enforcement and other public safety agencies.

Enterprise Management Information

- Market analysis and planning is the key to survival in transportation industries. A large share of information processing is devoted to data collection and modeling. Census data and DoT statistics are important sources for estimating market opportunities and providing consumers information. The DoT Research and Special Programs Administration's Office of Aviation Information, for instance, publishes data on air travel between major cities, as well as "on-time" performance results often referenced in commercial airline advertisements.

- Fleet and freight management systems rely on current inventories of rolling stock, containers, and handling equipment, including location, age, condition, and maintenance data. Railroads and motor carriers are developing systems to increase transportation asset utilization rates. Airlines maintain and report detailed information on aircraft condition and use it in maintenance management practices and to support airworthiness certification. And, in virtually every industry segment, inventory management is becoming highly automated and dependent on nationwide and global communications.

- Human resources management systems vary in sophistication between small trucking firms and large international airlines. One common characteristic of the transportation industry, however, is that its employees are highly mobile. As with their airplanes, railcars, and tractors, it is important for carriers to know the location and status of their people. Safety rules on operator rest periods impose data and communications requirements on these human resources management systems, which could be served through the NII.

PART III: Where Do We Want to Be?

The United States has one of the most efficient and effective transportation systems in the world. But improvements are possible in a number of areas. For example, there are some sectors of society—the elderly, the poor, the disabled, those living in remote rural areas and in inner cities—that do not have access to the same range and selection of transportation options as do others. Fortunately, there is reason for optimism that this and other issues can be addressed through new applications of information technologies.

Long-Term Goals

For the long-term future, DoT envisions a smarter, faster, safer, and more accessible transportation system functioning as a truly integrated, intermodal service covering air, water, road, rail, and transit. Such a system would benefit the productivity and efficiency of the nation's economy and help to mitigate transportation's energy and environmental impacts. Among the specific goals for the transportation system of the future are:

Improved Safety

- Fewer accidents and collisions by transportation vehicles.

- Far fewer deaths and injuries as a result of transportation activities.

- Faster response time by law enforcement, medical, fire, and rescue services to accidents and other emergency situations.

- Enhanced security for passengers and goods.

Increased Efficiency

- Reduced incidence and economic cost of traffic congestion.

- Expanded capacity of the existing transportation infrastructure through cost-effective improvements.
- Fewer delays caused by congestion or the lack of effective intermodal transfer services.
- More cost-effective technological advances and investments in transportation infrastructure, vehicles and support services.

Energy and Environmental Mitigation

- Reduced energy consumption per unit of travel through greater efficiency and by avoiding waste.
- Reduced emissions into the atmosphere, water, and land per unit of travel.
- Limited disruption of existing communities and land-use patterns.
- Safer movements of hazardous materials and other commodities that pose a threat to public health or the environment.

Enhanced Productivity

- An improved intermodal transportation system that ties America together.
- Lower cost transportation and logistics services.
- Development and growth of American companies, particularly defense-related companies, engaged in transportation research, manufacturing, and services.
- More competitive American exports through lower transportation costs and improved delivery.

Expanded Mobility

- Improved mobility for Americans with disabilities.
- Better information, both in terms of quality and quantity, for travelers and shippers.
- More transportation options for passenger travel and freight shipments.
- Greater availability of transportation services to under-served areas.

Short-Term Goals

Accomplishing these long-term goals depends on reaching first a number of short-term milestones:

- Establishing a consensus on the roles and responsibilities of participants in the transportation system—local, state, and Federal Government organizations; private sector transportation providers; and transportation users.
- Creating an environment in which all groups and individuals can participate, including new cooperative ventures to manage portions of the transportation system.
- Reaching acceptable compromises in balancing efficiency, mobility, safety, health, and environmental consequences.
- Agreeing upon a unified overall system architecture with uniform standards, procedures, and protocols for system development, implementation, operation, and maintenance.

PART IV: How Are We Going to Get There?

The future of intelligent transportation systems has yet to come into full view. It is a future that will be influenced by government efforts to establish an institutional and regulatory environment that is conducive to innovation. But the future will be most substantially determined by transportation system operators and users and their acceptance and willingness to pay for enhanced information services.

Several key questions and issues are subject to debate before ultimate policy decisions can be reached. Your comments and suggestions are a welcome and important part of the process.

Please provide any opinions you have to offer on the NII and its potential application in the intelligent transportation systems.

Questions and Issues to be Addressed

Successful adoption of NII technologies in the transportation arena will depend on whether timely, reliable information and meaningful services can be provided to transportation users. Moreover, developing NII applications will challenge government agencies and private firms to adapt or to create new models for partnership. Institutional, regulatory, and economic reforms are likely to be needed as well. DoT already has identified a number of non- technical issues that could either promote or hinder the development, implementation, or use of transportation applications of the NII. Several are outlined below, along with issues and questions for consideration and comment by interested parties.

Critical Technologies

Early assessments indicate that technological advances could make intelligent transportation systems more attractive in terms of cost and performance, yet note that existing information and communication technologies are frequently underutilized due to non technical factors. Do most of the required technologies for intelligent transportation systems exist? If these are used elsewhere, what is needed to gain widespread acceptance in transportation? Are applications research and technology demonstrations the most effective means to increase awareness of possibilities and benefits within the transportation sector? Are key technologies evident? Should the government attempt to identify critical technologies or rely upon the private sector to do so? Are joint technology initiatives needed in such ares as:

- Data fusion technology for combining Global Positioning System satellite navigation data with location data from Loran, a terrestrial radio navigation aid, with digital map data, and with data from a dead reckoning system to produce accurate information on the location of buses, trucks, trains, and cars.
- Monitoring and control system technology using digital motion detectors which could assist human operators monitor numerous vehicles over a wide metropolitan area.
- Spread spectrum communications that make efficient use of the radio-frequency spectrum can conserve an already crowded electromagnetic spectrum. For instance, low-powered, frequency-hopping devices can transmit critical transportation information virtually unnoticed by other users within the spectrum.
- Mobile data communication networks that can send emergency, maintenance, toll collection, vehicle identification, weather advisory, congestion, and automated vehicle location data to and from vehicles.
- Information security technology for ensuring that information systems and data communications are trustworthy, including encryption techniques to safeguard critical data.
- Wireless packet switching technology to enable error-free transmission of data to moving vehicles.
- Electronic maps and location equipment, and associated displays with high contrast and adequate resolution at low cost, in various forms: flat panel, interactive HDTV, and head-up windshield displays for example.
- Smart cards and tags optimally combined for transportation applications such as collecting tolls on-the-fly, controlling high-occupancy-vehicle lanes, providing fare media for bus, plane, or train tickets, and automatically activating specialized devices and transportation services for Americans with disabilities.

As part of the IVHS program, public outreach events are being held throughout the country to solicit public input regarding user service requirements and applicable technologies. Public comment on the broader aspects of intelligent

transportation systems and data resources is anticipated in response to this paper.

Public/Private Partnership and Roles

The policy intent is that the private sector will build, own, and operate the NII. The private sector thus is developing, marketing, and commercializing NII technologies, products and services.

Private sector participation in the development of transportation system applications also is encouraged yet may be impaired by traditional long-standing beliefs that the government is responsible for transportation operations. A question exists as to what extent government responsibilities to ensure that NII meets a broad range of societal goals, including environmental quality, equity, and access goals, lay outside the interests of private companies. The respective roles of public and private interests are evolving and will continue to do so for some time. Public perception as to the limits of public and private roles will be an important factor.

New forms of public / private partnership are foreseen. Are there practical models which can be adapted from other field to support the cooperative development and deployment of the NII and intelligent transportation systems? How can public and private interests each be protected in such alliances?

Moreover, the private sector has concerns that particular activities, especially joint ventures, could be found to violate antitrust laws. To what extent should relevant antitrust principles and laws be modified to avoid inappropriate hinderance of NII transportation applications? A preliminary DoT study concerning IVHS concluded that modified legislation is not necessary to affect the balance of public interests and competition safeguards. Do you agree?

Human Resource Training and Education

Another issue relates to the ability of state and local transportation departments and transit authorities to hire and retain workers with the technical and professional skills to manage and use NII services, either because of low pay or hiring restrictions. A study conducted on skills and training requirements for IVHS services indicated that in the long-term an adequate supply of trained workers to deploy, operate, and maintain IVHS user services should be available. In the interim, DoT is preparing training, education, and rotation programs for public agencies. Nonetheless, the capabilities that will be required of future transportation professionals has yet to be determined precisely. The extent to which such jobs will be viewed as attractive within the American workforce remains an open question as well.

Public Outreach and Awareness

Consumers will need to be aware of the NII and transportation applications if they are to use, buy, or fund its development. This paper is an initial attempt to increase public awareness of the possibilities. In addition to the public at large, local public agencies and small private companies also will require information about acquiring, accessing, and employing NII products and services. How can this best be accomplished? Are current DoT outreach efforts sufficient?

Regulatory and Legal Issues

Although many intelligent transportation system concepts are intended to enhance safety, these novel transportation systems raise tort and liability questions. Highway, air, marine, and rail transportation systems are responsible for moving millions of people and goods. Because the NII is in its infancy, it may be too soon to consider legislation or other actions to protect developers, users, and operators of NII products and services from liability risks. The NHTSA is undertaking research to prepare standards that may limit IVHS liability exposure by ensuring the application of sound engineering principles. Should extensive field testing of products be used as a means to ensure safe IVHS design and operation?

Intellectual Property Rights

The issue of intellectual property rights is especially important in cooperative efforts such as those envisioned in public/private partnerships for the development of advanced transportation applications of the NII. The private sector is concerned that public sector agencies will want to retain broad rights over NII technologies and services, thus reducing the ability to recover pre-development and research costs, and limiting profits from future sales. At the same time, public agencies are concerned that developers will limit access to computer software codes or other intellectual property needed to manage, distribute, and operate these technologies. To what extent are such concerns premature? Does current Federal patent policy afford sufficient protection for private sector developers? Are public agency concerns too demanding or unreasonable?

Funding Issues

Installing, operating, and maintaining advanced technologies will require substantial financial resources that may well exceed the budgets of public agencies. As a result, Federal, State, and local agencies may need to identify and develop new funding mechanisms. Are there innovative options available? To what extent should public agencies develop investment criteria and conduct cost-benefit analyses to determine the most effective investment of limited resources?

Accessibility and Social Equity

Current Administration policy is that the NII be accessible to everyone. However, access to some transportation applications of the NII will be accessible yet determined by a willingness to pay and ability to pay for services, raising concerns of an imbalance in the distribution of benefits among income groups. Social equity and access to transportation information is an important public policy issue yet to be fully resolved. How, and to what extent, should public agencies determine mechanisms for ensuring equitable access and affordability of technologies and services that are to be provided with public funds.

Beyond access considerations attributable to economic status, consideration must be given to making transportation applications of the NII accessible to Americans with disabilities. Thus special attention to user interface design will be needed. Such considerations are discussed elsewhere in this publication, and generally apply to intelligent transportation systems as well. However, are there special needs and considerations to be addressed?

Privacy and Security Issues

A wide array of surveillance and monitoring technologies, including fixed or mobile electronic sensors and video cameras, will be used to provide some intelligent transportation system services. This raises questions about individual privacy. Most people want their privacy protected, yet also expect benefits that are not possible without compromising privacy. To what extent should the benefits of the NII transportation applications be clearly shown to outweigh any privacy considerations.

To the extent to which proprietary and/or sensitive transportation information is to be transported over the NII, what mechanisms should be developed to ensure that information is protected and that personal anonymity is safeguarded? Is legislation limiting the public availability of personal identifying data related to transportation information needed? In what instances should advanced notification, as well as consent, to disclose information to third parties be required?

Environmental and Energy Issues

The Federal Government has numerous policies to safeguard environmental quality and engender energy conservation. Environmental externalities created by NII technologies and services are difficult to access with existing methods and analytical tools. To what extent should the government strive to develop better analytical tools and to perform field tests to assess the impacts on air, natural resources, and energy use of transportation applications of the NII?

Future DoT Involvement

Consistent with its leadership role, the DoT will examine issues critical to NII and its transportation applications. Development of the NII and related transportation applications will entail the following:

- Conducting research studies, including data collection and analysis, computer modeling, and developing national research and testbed facilities.
- Creating a suitable environment for NII transportation applications, including studies and analyses of non technical issues: social, economic, and legal obstacles and ways to resolve them; cost-benefit studies and impact analyses; and the definition of the responsibilities of various participants in the development, operation, and use of such systems.
- Defining NII transportation applications and determining the feasibility of concepts.
- Developing NII transportation applications with high public benefit but limited commercial potential, as well as systems for which the Government, rather than the private sector, is a substantial user.
- Promoting compatible NII technologies and services within multiple jurisdictions of the public and private sectors.

In summary, DoT agencies will devote significant resources to NII related R&D activities. This alone will not result in the future described herein. That future will require the unprecedented cooperation, both within DoT and with other federal agencies, academic institutions, and private industry. But more importantly, it will need public support from a broad cross section of Americans.

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Promoting Telecommuting: An Application of the National Information Infrastructure

DRAFT FOR PUBLIC COMMENT

"... Investments in telecommunications infrastructure that facilitate telecommuting should not only lead to ... transportation benefits, but may also have a synergistic ... effect on other transportation strategies ... required to cope with growing traffic congestion, urban air pollution, and national petroleum dependence (Energy, Emissions, and Social Consequences of Telecommuting, p. xiii)."

PART I: What is the Application Arena?

Telecommuting has been identified by both the National Performance Review (NPR) and President Clinton's Climate Change Action Plan as one solution to accommodate the demand for increased mobility and to enhance worker satisfaction. Indeed, President Clinton's recent memorandum on expanding family-friendly work arrangements directs federal agencies to support telecommuting and satellite work locations throughout the Executive Branch. Recent government studies also underscore telecommuting's favorable impact on transportation, energy, and environmental goals and the role played by the NII in furthering these outcomes.

The question to address, then, is: How can the NII help promote and support telecommuting and, thereby, assist in realizing its ends? The term telecommuting, as employed in this paper, refers to a means of performing work away from the principal office — typically at home or at a nearby telecenter. Home-based telecommuting, which has been occurring worldwide for more than 20 years, often requires no more than a telephone and notepad. Yet, those who work at home often times lack the sophisticated office technology that allows full access to information and speedy communication.

Driving Forces Behind Telecommuting

Three principal forces drive the public interest in promoting telecommuting: the environment, economics, and quality of life. In terms of the environment, many of the nation's metropolitan centers have significant problems meeting requirements of the Clean Air Act. Other locations face more moderate air quality hurdles, but current growth trends pose potential troubles. Beyond its degrading effect on the environment, over-reliance on the automobile for daily commuting also takes its toll on the earth's fossil fuel reserves. One way to improve air quality, reduce future environmental risks, and conserve energy resources is for employers to adopt telecommuting as part of an area-wide transportation demand management strategy. Economic forces are no less compelling. In many urban areas, peak-hour traffic is bumper-to-bumper for hours every weekday morning and evening. This snail's pace slows the daily commute for millions of office workers and for others who make their living, go to school, shop, or simply visit sites around the city. It also adds hours to delivery times for commercial vehicles, all the while introducing large amounts of pollutants into the air we breathe. When traffic is snarled, all economic activity is forced to downshift. Increasingly, employers are relocating to less congested areas to avoid the high cost of doing business in downtown settings. Given the innovations in telecommunications technologies, it is now also

possible to distribute some work to suburban and rural locations and reduce facilities costs with minimal loss of productivity.

Telecommuting is one approach to a distributed workforce and provides the additional benefit of increased worker productivity. Perhaps more than any other driving force, changing social values and more diverse and flexible life style preferences are having an impact on the American workplace. Two- and three-hour daily commutes added to an eight- or nine-hour workday keep family members apart far too long for quality relationships to flourish. There is little time to talk about the day's upcoming events at breakfast, help children with homework or discuss problems after school, or explore ideas for the family's summer trip around the dinner table. Moreover, there is less and less time or personal energy available to devote to community projects, volunteerism, and other civic activities. Here again, telecommuting holds the potential for tipping the scales back in the direction of more quality time with family and the community.

Potential Benefits to Society

Telecommuting, which brings work closer to the employee's residence, can take the form of working at home or at a nearby telecenter. These flexible workplace arrangements have demonstrated they can help organizations recruit and retain key personnel, increase accessibility for all employees, improve office productivity, increase use of new technology, and reduce facilities costs. Based on research from other private sector and public organization telecommuting experience, benefits to the employee are likely to include increased job satisfaction, reduced commuting time and transportation costs, diminished stress, improved quality of life, and improved family functioning. Societal contributions include environmental and energy conservation, less traffic congestion on area highways, reduced individual and family stress, increased civic involvement in local communities, and improved economic development at local and regional levels.

Telecommuting can also improve customer satisfaction. The National Performance Review provides insight into the link between employee empowerment and customer service. The report notes that "The Federal Government must ... create a workplace culture in which employees are trusted to do their best." It also quotes the Director of Marketing for General Motors as saying, "... there's a strong correlation between employee satisfaction and customer satisfaction. If your employees are unhappy ... about ... the quality of worklife, they won't worry about customers (*Creating a Government that Works Better and Costs Less*, p.85)."

The Changing Role of Central Cities

There is concern among some in the central cities that telecommuting and other forms of distributed work will take jobs and economic activity away from downtown areas. Some maintain that this sort of movement simply exacerbates urban decay and further separates large segments of our society. Experience shows that telecommuting programs usually benefit those who commute in from suburban and rural areas, rather than workers who reside in town.

However, many urban dwellers could benefit equally from reduced transportation costs, increased flexibility and quality of life considerations. Imagine a "smart Metro stop" in an inner-city community that had high-speed network access. Such a community asset could serve as a telecommuting center, a residentially based service node for consumers of public services, and as a local educational resource for neighborhood youth and families. Even though inner-city locations may not pose traffic-related air quality threats, quality of life and community economic development considerations alone may warrant such infrastructure investment. Similarly, remote rural areas that have traditionally been underserved can also benefit from connection to an improved National Information Infrastructure.

Through interagency, intergovernmental, and public-private partnerships, multi-purpose telecenters in "smart" inner-city neighborhoods and rural communities could also offer a wide range of telework and teleservice opportunities. By sharing facility and overhead costs, and perhaps expertise and other resources, center participants would gain many of the advantages of cooperatives and similar joint undertakings. Moreover, in-town telecenters can accommodate the increasing numbers of reverse-commuters who choose to live in pedestrian-friendly urban neighborhoods but whose work takes them outside the center city.

Related Policy Initiatives

The National Performance Review (NPR) recommended that the U.S. General Services Administration (GSA) and the U.S. Office of Personnel Management (OPM) develop a legislative proposal to enable flexiplace and telecommuting arrangements for more federal employees. It further recommended that the U.S. Department of Transportation (DoT) create and evaluate telecommuting programs. The Accompanying Report of the NPR (on reinventing human resources management) underscores the role of the Federal Government as a model employer.

> "The Federal Government should be viewed as a model employer in the availability and flexibility of quality worklife programs that emphasize the tools employees at all levels need to manage their work responsibilities and personal lives more effectively. Successful programs will foster interagency and intergovernmental partnerships, encourage cooperation between management and employees, spark collaborative ventures between public and private organizations, and bring harmony to the workplace and community in which they reside."

The federal government can also be an exemplar of how the modern organization relates to its customers and to the community in which it is located. Government agencies can add value to what state and local officials and others in the private sector have already initiated. The federal government can seek to use its presence in America's communities to facilitate speedy access to the NII.

Labor Relations Considerations

Labor unions have raised several concerns regarding flexiplace arrangements. While unions have generally been supportive of telecommuting programs, they caution employees, stewards, and program advocates to keep an eye on:

- the union's continued ability to effectively represent telecommuters who are not in the principal workplace;
- equity issues with respect to selection (e.g., rank, performance ratings, residence, etc.) and level of support (e.g., sophistication of equipment, clerical assistance, etc.);
- return of micro-management procedures and piecework assignment techniques;
- maintenance of Fair Labor Standards Act provisions (e.g., overtime and premium pay matters) in remote, unsupervised locations;
- home inspections, electronic monitoring, and other means of invading the worker's privacy; and
- unwarranted efforts to convert career employees to contract personnel.

In keeping with the Administration's labor-management partnership initiatives, the Federal Government can be a model employer in this regard as well. Union leadership should be involved early in the process of planning telecommuting programs and assuring that concerns are addressed effectively throughout the programs' implementation.

PART II: Where Are We Now?

The First Wave: International Benchmarking

Telecommuting has been underway both here and abroad for several decades. Millions of workers worldwide telecommute from home. An estimated five million Americans telecommute from home, and indications are that this number

continues to grow. According to a recent study by the University of California-Davis, the first formal telecenter was established in 1981 along the Marne Valley. Planned as a decentralized job relocation effort, this early attempt at a joint, public-private undertaking was designed to accommodate 100 employees. The study, funded by DoT and the California Department of Transportation (Caltrans), identified variations of this model, including approximately 60 separate ventures in a dozen nations. Some were aimed at slowing the pace of rural to urban migration, others to promote economic development, several to take advantage of lower wages and operating costs, and a growing number targeting individuals whose assignments could benefit from a less stressful environment.

The Bank of Montreal initiated its first "floating office" in 1991. In this arrangement, employees work out of branch offices, at a client site, or at home using a lap-top computer and remain available by phone or pager throughout the work day. The effort has proven successful and has pioneered in transitioning to a results-oriented form of supervision. Every effort is made to reduce worker isolation by holding periodic briefings and meetings that all employees must attend. The UC-Davis report indicates the Canadian banking firm is realizing significant cost savings, improved customer service, and higher employee cooperation and morale.

In Japan, the private sector has jumped out front in experimenting with telecommuting arrangements. These ventures are usually high-tech experiments funded by telecommunications firms, office equipment suppliers, and construction companies. One center (in Shiki, just outside Tokyo) evolved to become a job center for women in clerical and secretarial fields. Some of these opportunities can include part-time and home-based assignments. Another Japanese innovation, the "creative office," combines telecommuting with a resort setting to help employees recover from fatigue and to rediscover a creative muse. One such office is located in Kumamoto, 600 miles from Tokyo in southwest Japan. During the average 2 week stay, employees perform their normal tasks of research, planning and market analysis. At the Hokkaido Niseko resort office, workers reported "...improved creative output, fresh perspectives, and self-discovery."

Yet another application of telecommuting technology has been in Sweden through employment of the "office train." This experiment began in 1986 and involves as many as 20 managers working for half-pay during an 80 minute train ride in and out of Stockholm. Also in 1986, Crédit Suisse established fully outfitted telecenters to meet computer specialist shortages in Basle, Lausanne, Lugano, Winterthur, and Zug. They also believe their employees will respond favorably to such benefits as: flexible work schedules, shorter commuting time, and improved quality of life. In Devon, England, Oakmoor Telecentres Ltd. is marketing modular telecenter units, designed in collaboration with Digital Equipment Co., that range in size from 46 to 76 square meters. Other sites in England offer "telecottages" designed for computer-based information services, training, "telebusinesses," or for start-up of new, small businesses.

A more recent phenomenon overseas is the "community tele-service center." This type facility differs from most telecottages in that it provides a wider range of support and amenities and typically includes a full-time manager and part-time clerical employee. The UC-Davis study indicates these centers usually offer: "... remote database access, ... fax and electronic mail, data processing services, consultation on use of services, town meeting facilities, distance learning facilities ..., video production/editing equipment and facilities, and facilities to assist small business formation for information-based services." The report cites 65 such teleservice centers in operation as of 1990, most located throughout Scandinavia and some in other regions as far away as Benin, Sri Lanka, and Brazil. Much of this development is aimed at stemming the seemingly inexorable movement from the countryside into congested urban areas.

The American Experience

In the United States, the first center was established by Pacific-Bell in 1985. Today, an

estimated five million American workers nationwide use an alternate workplace one or more days a week. Most are found in the private sector, commonly working at home. Within the last 5 years, there have been several innovative telecommuting center experiments in Hawaii, California, and Washington state. Outside Honolulu, Hawaii, the State Department of Transportation has been sponsoring an inter-governmental facility for more than 5 years. Sixty to seventy-five miles east of Los Angeles, California, local officials, and some private concerns established a cluster of "telebusiness" centers. Designed to improve air quality, these projects were made available to both public and private organizations. In 1992, the Washington State Energy Office concluded its 2-year experiment with a telecommuting center for state employees in the Puget Sound area.

The UC-Davis study includes information on other telecenter and related projects in California, Washington, Illinois, New York, Colorado, Kansas, Kentucky, Minnesota, and North Dakota. They run the gamut of urban, rural, residential non fixed settings and reflect highly divergent use patterns as well. This first generation of state and local government-supported telecommuting centers has pioneered in basic design issues and has clarified technology, administration, and human relations considerations. Among other lessons learned during the first wave, most now agree that it is critical to:

- provide training to all participants (including supervisors and co-workers);
- obtain a long-term commitment from sponsors;
- implement an aggressive marketing strategy early in the process;
- be flexible in understanding and responding to customer requirements (technical or otherwise);
- diversify the customer base to maximize financial viability; and
- plan for operation of the center with little or no continued subsidy.

While these early telecommuting center projects have helped clarify some technology and management issues and have been well received by participants, none has achieved financial success. Once an initial subsidy has run its course, participation drops off. Centers have either then closed or local government has stepped in to operate the center and buy more time. Until recently, almost no effort has been made to market center services to federal agencies or their customers, and utilization rates remain too low to keep the pilot sites operating in the black or even at the break-even point. Again, while successful in many ways, these pioneering ventures have been characterized by:

- limited use of the nation's ever-improving information infrastructure;
- single-purpose applications (i.e., telework arrangements with little or no connection to home-based programs);
- no more than a few facilities in a metropolitan area;
- limited marketing efforts; and
- minimal leadership and support from top management, employee unions, and elected officials.

Technology Issues

For the most part, existing technology and the development pace of new technology is adequate for most current telecommuting requirements. However, technological advances such as the development of high bandwidth communications (beyond ISDN) would benefit existing telecommuting efforts and are increasingly important as more users and more diverse applications make demands on the system. Current levels of telecommuting involve only a small, narrow portion of our population, and program focus has been primarily on workstation relocation. As telecommuting expands to the more general public and includes more applications (customer services, telelearning, telemedicine, telelibraries, etc.), technological readiness will be crucial to gaining widespread acceptance and confidence. Some nagging issues that have already become apparent include:

- cost of technology for users;
- geographical and cultural availability of technology;

- user-friendliness of NII elements;
- ease of messaging and call-forwarding;
- ease and speed of converting hard copy to automated form;
- ease of use and of fax/modems and related software;
- ease of establishing data linkages from remote locations;
- phone company incompatibilities and cost of line charges;
- full, effective use of videoconferencing and interactive video technology;
- credible data security; and
- software compatibility problems.

Private Sector Trends

During the past several years, some large private firms have begun shifting sizeable segments of their office workforce - particularly in sales and financial management - to telecommuting arrangements. In Denver, Colorado and Charlottesville, Virginia, IBM has furnished employees with furniture and equipment to work at home when they are not in the field with customers. On the occasion this telecommuting workforce requires space or support at the principal workplace, IBM makes available "shared space" in a setting redesigned for intermittent use. There is a dual business rationale behind this arrangement: it places the workforce (e.g., salespersons and customer representatives) closer to their clients, and it allows the firm to significantly reduce facility costs. A variation on the approach to sharing office space, is the "virtual office" that AT&T has been using to downsize its sales office operations. By replacing such offices with intermittent workstations, AT&T has made this cost-saving transition in New York, Connecticut, and Massachusetts.

Another phenomenon, "hoteling," was initiated by Ernst & Young in their Chicago accounting and consulting operation in 1992. This arrangement is designed to accommodate employees who spend the majority of their workdays out in the field with clients. To meet worker needs on in-office days, the firm makes available a private workstation typically integrated with space occupied by peers and related functions. A "hotel coordinator" orchestrates the process of taking reservations, assigning space, providing office support, and programming phone numbers. According to the UC-Davis study, in the first year Ernst & Young reduced space requirements by 7 percent, and the company expects to eventually shrink its office space requirements nationwide by 60,960 square meters for a savings of $40 million a year.

In response to the growing trend of satellite and other remote work site placement, a new industry of "executive office suites" has begun to emerge both in the United States and abroad. Not unlike telecommuting centers, executive suites typically offer multi-user services such as shared space, modern equipment and support staff on an intermittent basis. However, as the UC-Davis report indicates, the latter are usually located on prime commercial real estate and have an upscale image "with rates and amenities oriented toward the upper management level rather than the rank-and-file worker." A hybrid of the executive suite, the "Comm Center," a registered trademark of the Office Technology Group in Long Beach, California, specializes in providing a wide range of accommodations (at different rates) to the one- or two-person office. Notwithstanding these innovations, American business has not moved aggressively to make telecommuting a management option to improve the bottom line.

Recent Public Sector Activity

In 1992, California Department of Transportation (Caltrans) launched a new effort in cooperation with UC-Davis to establish 12 or more small, neighborhood-based telecommuting centers throughout the state. Augmenting this project is another Caltrans undertaking likely to generate six or more sites with the California Community College system. Supported by funding from DoT's Federal Highway Administration (through the Intermodal Surface Transportation Efficiency Act, or ISTEA), the Caltrans sites are expected to determine the value of new telecommunication technology as a means of increased mobility, relieve traffic congestion, conserve energy, and improve air quality. To this end, Caltrans is

partnering with a wide range of local instrumentalities to gain insight into how best to initiate and administer such efforts. Partners to date include: regional transportation management authorities, local economic development offices and redevelopment agencies, state and county fairs, public school systems, community college districts, and other public-private collaborations.

Other states and localities are also continuing to experiment with telecommuting and related information technologies applications. A state and private coalition in Kentucky is attempting to employ high-tech telecommunications to improve access and promote community economic development in the more remote rural areas of the state. Activities just now getting underway include: regional telework and teleservice centers; local kiosk availability; small business incubator support; distance learning through interactive video technology; and other information services to the citizen. Iowa is working with a consortium of federal agencies to explore similar applications for use in a statewide fiber-optic environment. Planned efforts are targeting such uses as remote medical diagnostics for veterans through nodal communication with regional medical centers, tax filing and consultation with the Internal Revenue Service (IRS), benefits counseling and application with the Social Security Administration (SSA), and other applications.

In Davis, California, a non profit coalition, assisted by a Caltrans grant, is working to establish an interactive community computer network. Called the Davis Community Network, this local education and information system uses modern telecommunication technology to make available at modest cost to local residents: electronic mail, conferencing, forums for public discussions, bulletin boards (describing city services and community resources), information from volunteers, on-line library reference desk, and many other possibilities. It will also represent a multi-channel link between the public and local schools, the public library, city hall, hospitals, and community service organizations. Beyond these local applications, the community network provides access to the Internet and to a wide range of distance learning opportunities. Tied to a telecommuting center, this resource would make it possible for students and other residents with their own computer and modem to enjoy these benefits.

Federal Initiatives

The Federal Government has been experimenting with flexible workplace arrangements and telecommuting for the last 5 years. Between June 1990 and June 1992, OPM and GSA operated and evaluated a home-based, flexiplace pilot program that included 15 separate agencies and 1,000 participating employees nationwide. The overwhelming majority of employees and supervisors judged flexiplace arrangements to be a desirable workplace option.

As a result of this pilot effort, OPM has since written all federal agencies assuring them of their authority to establish telecommuting programs and encouraging their use. Both GSA and DoT have publicly promoted federal agency use of telecommuting as a means of reducing traffic and improving air quality. Agencies that participated in the 2-year pilot project and some others have also developed and implemented formal, home-based telecommuting programs. Moreover, the Departments of Defense (DOD) and Veterans Affairs (VA) have telecommuting programs dedicated to persons with disabilities and to reducing the number and duration of worker compensation cases through prevention and better management of the re-entry process. Also, several agencies are considering telecommuting in conjunction with office space reduction and workplace reconfiguration efforts.

While nationwide an estimated five million Americans telecommute, there are fewer than 2000 federal employees (0.1 percent of the workforce) currently participating in telecommuting programs. Most federal telecommuters work at home one or two days a week and spend the remainder of the work week at a principal workplace. Presently, approximately 10 percent of those telecommuting participate in center-based programs. Little information has been collected on home-based arrangements since the 2 year

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flexiplace pilot project administered jointly by OPM and GSA was completed in June 1992. Also, there is no information system currently in place to gather data on telecommuters by agency and by air quality nonattainment area.

During the past 2 years, the Congress appropriated $6 million for GSA to establish pilot telecommuting centers in outlying areas of the nation's capital. For use by federal employees who currently travel long distances between home and the workplace, each pilot center that has already opened involves an intergovernmental partnership. In southern Maryland, GSA's partner is a community college. In Hagerstown, Maryland, the venture has GSA partnering with a local consortium that includes a U.S. Army garrison, the city and county governments, and the local junior college. A partnership in Winchester, Virginia relies on the U.S. Army Corps of Engineers (USACE) in cooperation with the local economic development commission. The Fredericksburg, Virginia initiative is led by the area development corporation, a local government organization representing the city and four surrounding counties.

Early in 1994, GSA established three emergency telecommuting centers in the greater Los Angeles metropolitan area. In response to the Northridge earthquake, GSA set up centers to the north and west of the city and is currently exploring additional sites in the greater metropolitan area. The emergency centers opened only weeks after the January 17 earthquake. The GSA quickly located available space, leased and equipped it, and arranged for the provision of necessary administrative and programmatic support with the local Cooperative Administrative Support Unit (CASU). One of 49 interagency cooperatives sponsored nationally by GSA, the Los Angeles CASU is hosted locally by the IRS and provides a wide range of administrative support services to area agencies.

Interestingly, it has not only been federal employees who have benefitted from the markedly reduced commuting time. Agency customers are also spared the long trip into downtown Los Angeles to obtain required services. Thus, at the peak of this year's tax season, taxpayers in the Santa Clarita Valley could get help from IRS employees at the Valencia Telecommuting Center only 5 or 10 minutes away. Similarly, veterans could substitute a tedious drive into west Los Angeles with a short, pleasant one to the same facility to receive guidance from a Department of VA benefits counselor.

To build on this well-received start, GSA and the local CASU are exploring telecenter partnerships with state and local officials. Some of these partnerships reinforce efforts initiated by Caltrans and other local ventures. For example, the Institute for Local Self-Government has initiated a "facilities exchange" program that attempts to broker telecommuting space across jurisdictional boundaries. All these prospective partnerships make more enterprising use of existing public assets (e.g., underutilized space, equipment, human resources), thus reducing the cost for center participants and their employers. Some undertakings are also designed to preserve and re-use historic buildings.

PART III: Where Do We Want to Be?

Short-Term Goals

In its first 20 years, "flexitime" has taken on many faces in both the public and private sectors, including flexible work hours, compressed work schedules, and other temporary arrangements to accommodate the exigencies of contemporary life. Today, for example, it is estimated that 35-40 percent of the federal civilian workforce "flexes" with some regularity. Must the parallel "flexiplace" revolution take an entire generation to gain currency? In fact, the term telecommuting was coined here in the United States over 20 years ago. Will it now take another 20 years for flexiplace arrangements to achieve the utilization rates that flexitime presently enjoys?

The Climate Change Action Plan published just last year directs the U.S. Environmental Protection Agency (EPA) and DoT to take a series of actions designed to promote home-based and center-based telecommuting. These actions direct that:

- EPA, in consultation with DoT, issue guidance to states to take pro-telecommuting measures (e.g., reforming local zoning ordinances; providing employer trip reduction and tax incentives; and implementing telecommuting programs for state and local employees);
- DoT encourage states to use ISTEA funds to initiate or expand telecommuting programs;
- DoT implement a federal telecommuting pilot project with the goal of getting 1 to 2 percent of federal employees to work at home at least one day a week; and
- DoT, in conjunction with other agencies, promote part-time, home-based telecommuting to reduce traffic congestion and promote energy conservation.

Clearly, the federal government can begin immediately to demonstrate its leadership and commitment in this area by serving as a model employer. The President's memorandum implementing this recommendation is an important first step. It directs OPM and GSA to work with agencies to expand flexible work arrangements and directs the President's Management Council (PMC) and the OMB to provide implementation guidance on these actions. Accordingly, the Federal Government could aim to increase federal telecommuting levels to more than 60,000 employees (3 percent of the federal workforce) by the end of fiscal year 1997. Serving as a catalyst — particularly if linked with intergovernmental and public-private partnership arrangements — this short-term effort would demonstrate the workability and efficacy of both home-based and center-based telecommuting and should trigger increased state and local government and private sector involvement.

With the endorsement of the PMC, DoT and GSA should lead an interagency team to plan, implement and evaluate a 3-year initiative targeting as many as 30 metropolitan areas. Each local undertaking should encourage and support flexible work arrangements (such as home-based telecommuting) and attempt to establish a network of community-based telecenters throughout the metropolitan region. Many centers could provide multiple services (including support to home-based telecommuters) with the number of centers ranging from 12 to 24 per region. Workstations may also vary from a low of 10 or 15 for neighborhood settings to as many as 50 or more at regional centers.

Given the multi-fold purposes of the initiative, other team members should include active representatives from: OPM, EPA, DOD, VA, the Departments of Labor (DOL), Health and Human Services (HHS), Treasury (TD), Agriculture (USDA), Interior (DOI), Energy (DOE), Commerce (DOC), Housing and Urban Development (HUD), and Education (EDUC); the U.S. Small Business Administration (SBA), the Small Agency Council, and national federal labor unions.

To illustrate the synergistic mission-related applications made possible in such an undertaking, consider the desirability of:

- the Corporation for National Service (CNS) funding projects for college graduates recruited from inner-city or rural communities to serve as telecenter administrators or outreach workers in these locations;
- VA benefits counselors providing face-to-face services to veterans in a local telecenter;
- IRS field staff interacting directly with American taxpayers in their own communities;
- co-located federal, state and\or local program personnel providing one-stop advice and consultation to recipients of public assistance programs (e.g., Aid to Families With Dependent Children, Food Stamps, and Medicaid);
- Immigration and Naturalization Service (INS) or Passport Office staff providing cultural-friendly assistance to immigrants in their own neighborhood (perhaps in conjunction with young volunteers or a CNS project);
- linkages with local HUD and USDA "empowerment zone and enterprise community" efforts, such as: Drug Free

Schools and Communities, the Urban Community Service Program, Community Initiative Programs, Early Childhood Development Programs, Community Development Block Grants, EDA Public Works Program, and many others; and

- collaboration with Federal Transit Administration (FTA) "livable communities" projects - particularly those designed to enhance facilities such as: transit stations, park and ride lots, and transfer stations; and
- coordination with related programs to: improve educational opportunities, increase access to affordable housing, enhance job training and employment efforts, and increase crime prevention at the local level.

Target area selection should be based on four considerations:

- ozone and carbon monoxide non-attainment problems;
- potential for improved customer service;
- size of the local federal community; and
- geographic dispersion.

Thirty metropolitan areas that meet these criteria include:

- Atlanta, Georgia
- Baltimore, Maryland
- Boston, Massachusetts
- Chicago, Illinois
- Cincinnati, Ohio
- Cleveland, Ohio
- Dallas-Fort Worth, Texas
- Denver, Colorado
- Detroit, Michigan
- Fresno, California
- Houston, Texas
- Kansas City, Missouri
- Los Angeles, California
- Miami, Florida
- Minneapolis-St. Paul, Minnesota
- Milwaukee, Wisconsin
- New Orleans, Louisianna
- Norfolk, Virginia
- New York, New York
- Philadelphia, Pennsylvania
- Phoenix, Arizona
- Pittsburgh, Pennsylvania
- Portland, Oregon
- Raleigh-Durham, North Carolina
- Sacramento, California
- San Diego, California
- San Francisco, California
- St. Louis, Missouri
- Seattle, Washington
- Washington, District of Columbia

Funding support should be sought through various agency appropriation authorities. It is estimated that at least $50 million will be needed during FY 1995-97 to spur significant federal participation in telecenter activities in the short term. Because agencies have not budgeted for these needs and will require time to re-engineer their principal office operations, such additional funding support will determine the extent of increased telecommuting activity (in both the public and private sectors) during the next several years.

Telecommuting as a Reinvention Laboratory

To reinforce the enterprising nature of this undertaking, the PMC should designate the project an interagency reinvention laboratory. During the course of the experiment, government managers and the PMC should examine such impediments as:

- federal restrictions on intergovernmental and public-private partnerships;
- restrictive interpretation of federal appropriations law limiting use of funds for innovative solutions to transportation, air quality and related problems; and
- state and local restrictions on and disincentives for telecommuting in both the public and private sectors.

Measures of Success

- Outcomes measured in surveys and focus groups should include: changes in both home-based and center-based telecommuting levels in federal, state, and local government

organizations and within the private sector;
- changes in worker and office productivity;
- changes in environmental, energy and transportation factors (e.g., reduced air pollution, reduced consumption of fossil fuels, reduced congestion on major roadways, etc.);
- changes in application of new office technologies;
- changes in agency customer service practices;
- changes in citizen access to the national information infrastructure; and
- changes in family and community life having implications for improved social functioning.

This project also should examine the impact on inner-city and remote rural community access to flexible workplace opportunities and to information technology, telecommuter spending patterns and community involvement, utilization and impact of office technology, office furnishings and ecology, and other related matters. Moreover, the evaluation should be conducted in collaboration with similar action research funded by DoT and Caltrans at UC-Davis. Lastly, the development of telecommuting centers provides an opportunity to utilize and evaluate advances in office equipment, furnishings, environments (both physical and social), and designs. There have been several recent studies showing productivity improvements resulting from factors such as increased ventilation and access to natural light. The project should examine a wide range of office factors and their relationship to job performance and quality of work life.

A Vision for the Future

Looking to the future, government officials should consider the following activities and policies to promote home-based telecommuting and telecenter growth:

- extensive experimentation with distributed work approaches in the public and private sectors;
- demonstration projects and research on co-location of federal, state, and local counterpart staff at multi-purpose resource centers;
- experimentation with shared facility arrangements among federal, state and local agencies to render financially feasible organization presence in remote rural areas;
- tax incentives for employers and individuals to transition to home-based and/or center-based telecommuting arrangements;
- more flexible use of existing appropriation authorities allowing states and localities discretion tailoring the new information infrastructure;
- more flexible use of workers compensation law and regulation to provide alternative work opportunities to disabled workers (thus reducing total compensation costs and bringing workers back into productive employment);
- experimentation with telecenters in supporting neighborhood-based, assisted-living environments for persons with disabilities or frail elderly Americans;
- more flexible use of flexitime rules and procedures to allow employees to benefit from their own personal peak productivity periods; and
- examination of federal wage laws restricting work options available for workers and employers in liability issues.

Some key features and services offered at local centers might include:

- computerized access to federal, state and local job listings, applications and counseling; social security, health, and retirement benefits information; and other public services that can be automated;
- One-Stop Capital Shops (OSCS) designed to target lending and community development tools to small and minority businesses in distressed communities and underserved markets (discussed in *Building Communities: Together*, p.10);
- OSCSs located in Empowerment Zones or Enterprise Communities serving as national and regional capital distribution points for underserved markets;
- use as an access point for participatory democracy initiatives allowing and encouraging NII access to participate.

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attend, monitor government or other civic activities in distant locations;
- customer service/business office facilities for private sector companies (and incubator support for small businesses;
- computers using pen and voice recognition;
- library access (searches, abstracts, consumer info etc.) and access to business services such as the Commerce Business Daily or to advice and guidance from DOL's contracting regulations and requirements;
- on-site training for use of all these services; and
- shuttle and messenger services among centers and between the center and downtown offices.

Further, local communities might experiment with a mobile version of the multi-purpose center (e.g., a trailer or "infomobile") for inner-city neighborhoods. The District of Columbia's Office of Maternal and Child Health has been using mobile "Mom" trailers to help improve prenatal health through outreach and information. The District is also using roving municipal centers. Local officials could use trailers to provide a limited version of the full range of teleservices offered at fixed centers. Some of the international experiments in this area may have transferable aspects.

PART IV: How Are We Going to Get There?

National Telecommuting Project

The principal strategy for promoting this increase in telecommuting in the short term should rely heavily on intergovernmental and public-private partnerships at both the national and local levels. The lead agencies (DoT and GSA) should establish a national project team (NPT) and designate sponsors in each metropolitan area to lead local project teams (LPTs). The NPT should provide field managers with program guidance, technical support, organizational and marketing assistance, and oversee and evaluate project outcomes on behalf of the PMC. The NPT should coordinate national efforts to foster increased federal employee participation in agency flexiplace programs and should consult with national representatives of state and local interest groups (e.g., National Association of Counties, League of Cities, etc.) and related private sector organizations (e.g., Conference Board, U.S. Chamber of Commerce, etc.) to gain additional support.

In each target community, local teams should offer symposia on telecommuting issues and related programs. Symposia should be directed to area partnership members and representatives of other interested organizations. Moreover, the LPT should develop area-specific plans in consultation with appropriate federal, state, and local officials and with private sector groups. At the federal level, this should include: affected agencies; field managers; Federal Executive Boards and Associations, and CASUs (many of which have already begun cross-servicing with state and local counterpart organizations). At the state and local level, contacts should be made with: state agency officials; municipal leaders; councils of government; metropolitan planning organizations; state associations of counties; statewide city management organizations; empowerment zone and enterprise community officials; and others with interest and/or resources. In addition, private sector involvement should be pursued through local chambers of commerce, boards of trade and other individual firms or groups that wish to make a contribution.

Building on telecommuting projects already underway in Washington, DC and California and on other ventures begun even earlier, the team should seek to expand existing partnerships in these locations and initiate new ventures in other metropolitan areas. Partnerships could include shared-use or service arrangements with community colleges, local government offices, underutilized state or federal government facilities (including DoD installations, community malls, shopping centers and professional complexes, local utility operations, private professional, hoteling or business service centers, state and/or county fairs, regional economic and technology development councils, local schools and libraries, and other public and private community economic development

undertakings. It is anticipated that such partnerships will target underutilized facilities and make it possible to offer other family and community-friendly amenities, including service kiosks, public access to the information highway, child care, local fitness programs, training, and distance-learning educational opportunities.

Program emphasis should be on increasing both work-at-home arrangements and telecenter utilization, with centers also serving as an office support mechanism for home-based telecommuters. Support for those working at home could include: coaching, technical assistance, counseling, and drop-in administrative support (e.g., laser printer, copier or fax use; videoconferencing; mailhandling; etc.). Agency heads should urge senior managers to encourage home-based telecommuting and should provide full technical and administrative support for these arrangements. Project teams should assure that agencies have access to the latest information and techniques in this regard and should make available cross-agency shared support where needed.

Furthermore, every effort should be made to design centers so that agencies can bring services closer to their customers (e.g., taxpayers, veterans, social security recipients, farmers, small businesspersons, etc.). As local projects are planned, officials from participating agencies (at all levels of government) should have an opportunity to use the telecenter as a platform for other applications. Given the investment in modern telecommunications technology (e.g., TCP/IP routers, narrowband and broadband ISDN, ATM/SONET, etc.), multi-purpose use will bring down unit costs for all participants. Such economies of scale can also make it possible for federal agencies to maintain service capabilities in suburban and rural areas if only on an intermittent basis (e.g., once or twice a week).

Project planners should consult with local transit authorities to extend bus routes and other transportation services to new locations. Every effort should be made to maximize transportation demand management benefits. Air quality and energy conservation are, after all, two of the principal driving forces behind the initiative. Local projects could experiment with making available clean fuel shuttles and dial-a-ride programs and small, short-range, low cost electric vehicles for those who cannot walk or bike between home and the nearby center.

Streamlining Considerations

Employing telecommuting centers as hubs to support increased work-at-home arrangements will also lower unit costs for the employer. This will require technical and administrative support for telecommuters and their supervisors and related training, marketing and evaluation activities. As more employees from the same organization telecommute, an agency or firm can begin to redesign its principal office for more intermittent use and generate savings to offset telecommuting participation costs. To this end, GSA Regional Offices should provide office space planning and reconfiguration assistance to local federal managers as requested. Local projects should be encouraged to make such assistance available to other public and private employers (possibly through area phone companies and others in the private sector with such expertise) as further inducement to make telecommuting happen in their organizations.

Conclusion

Let us return to our initial question: How can the NII help promote and realize the ends of telecommuting? In the long run, planners and implementors of NII applications can continue the work to which many from across the globe have already contributed. They can tackle the remaining technology and management barriers, experiment with more holistic and synergistic models, and address outstanding public policy issues. In the short run, having the Federal Government lead by example should demonstrate the multi-fold benefits of telecommuting and clarify how the new information infrastructure can be of use.

The proposed 3-year initiative, which builds on the learning and programmatic successes of earlier efforts, differs from these pioneering

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ventures in six strategically significant respects. The approach makes more extensive use of the nation's evolving information infrastructure, thereby rendering center-based and even home-based telecommuting much more user-, employer-, and citizen-friendly. It relies on multiple NII applications to create economies of scale and synergism, thus bringing center services within closer financial reach of employers and private citizens. This generation of centers should also provide employers with a metropolitan areawide network of sizeable, community-based facilities (not merely one or two small pilot projects). This should make it possible for employers to generate the number of participants within their organizations to warrant redesign and release of space to actually reduce operating costs. It involves considerably more extensive and higher level marketing. And, lastly, this initiative requires significant leadership and support from top agency management (among others, PMC members, employee unions, and key elected officials) at the federal, state, and local levels.

While the central theme of this paper is telecommuting, increased NII support provides additional benefits from technology investments. For example, telecenters hold significant potential for bringing government services closer to the public. This will not only eliminate lengthy commutes for employees, but should enhance mobility for citizen customers as well. Viewed as the anchor for a multi-purpose resource facility, a community-based telecenter cou'd include such applications as:

- support for home-based telecommuters;
- interagency/intergovernmental service teams;
- interactive customer service kiosks;
- drop-in citizen access to the information superhighway (e.g., electronic bulletin boards, information and referral services, volunteer opportunities, Internet, and electronic town hall meetings);
- teleconferencing and videoconferencing for both workers and private citizens;
- health care information, remote medical diagnostics and other sophisticated information technology made increasingly accessible for rural populations;
- advanced computer accommodations that increase access for people with disabilities; and
- a wide range of distance-learning and related educational opportunities for those in both underserved rural and inner-city locations.

The longer-term vision for telecommuting should aim to gain more rapid acceptance of the concept, introduce distributed work approaches to a significant cross-section of the American workforce, and bring public services closer to where government's workers and customers reside. Using the nation's successful experience with flexible work schedules (i.e., flexitime), we see no reason that flexiplace arrangements cannot climb to 20 to 30 percent of the workforce by early in the next decade. Moreover, these efforts should attempt to reinforce other goals and values relative to environmental, economic and societal functioning. Continued emphasis also should be placed on aiding inner-city and remote rural area access to the nation's evolving information infrastructure.

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The Effect of the National Information Infrastructure (NII) on Local, State, and Federal Emergency Management

DRAFT FOR PUBLIC COMMENT

PART I: What is the Application Arena?

Emergency Management can be defined as —

a public educated on what to do before, during, and after a disaster to protect themselves, their families, their homes, and their businesses; structures located out of harm's way and built according to improved codes; governments and private organizations with proven effective plans, necessary resources, and rigorous training for disaster response; and community plans, prepared in advance, for recovery and reconstruction after a disaster.[1]

As described above, emergency management deals with the mitigation of, preparation and training for, response to, and recovery from disasters. While emergency management requires many implementation tools, one of the most critical and ripe for improvement is the use of information technology to support the efforts of emergency managers. Emergency managers provide guidance when dealing with many types of natural or manmade disasters that can cause devastating loss of life, injury, emotional distress, and material destruction. When a disaster strikes, everyone is affected either as a victim, a survivor, or a member of a relief team. At optimum levels, there would be a combined effort of Federal, State, and local emergency management officials working with the public and private sector to return the situation to normal.

Natural disasters can be complex, occurring with a wide range of intensities. Some events are instantaneous and offer no window of warning, such as the Northridge California earthquake in January 1994. Some offer short windows in which to alert the public to take actions such as the tornadoes in the Southeast, or the more than 10,000 annual severe thunderstorms. Others occur less frequently and are typically more expansive, with some warning time to allow the public time to prepare. Examples include many hurricanes, such as Hurricanes Iniki and Andrew, and the Midwest floods of 1993. Proper preparation for and response to all emergencies rely on coordinated efforts. In addition to natural disasters, each year there is an increase in manmade incidents which can be just as devastating as natural disasters.

Table 1 is a summary showing the number of Presidentially declared disasters or emergencies in Fiscal Year 1993. The table only shows those disasters which where so devastating that they resulted in a Presidential Declaration. One storm can cause multiple declarations since they are declared on a State by State basis. The actual number of smaller, localized disasters is much higher (obviously, any disaster is major to its victims). For instance, in 1993, there were 1,173 tornadoes which touched down in the United States, resulting in 33 deaths.

Table 1. Presidential Declarations by Fiscal Year

Fiscal Year	1989	1990	1991	1992	1993	1994*
Drought	0	0	0	1	1	0
Earthquake	0	1	0	2	1	2
Fire	1	5	2	11	7	2
Flood	14	14	17	15	20	2
Human-caused	0	0	0	0	1	0
Hurrican/typhoon	5	2	10	9	2	0
Severe/storms	2	0	1	6	3	14
Snow/Ice	1	3	5	2	18	6
Tornado	7	13	6	8	12	2
Toxic Substances	0	0	0	1	0	0
Volcano	0	1	0	0	0	0
Totals	30	39	41	55	65	28

* *Through 06/22/94*

Enhancements to information systems supporting emergency management through the improvement of the National Information Infrastructure (NII) will directly result in saving of lives, reduction in human suffering, and monetary savings from a reduction in the impact of disasters. These enhancements will save the lives of both the emergency responders and the general public. Issues of public safety are an integral part of emergency management. It doesn't matter where people live or work; every person in this nation is a potential victim of one or more natural or man-made disasters. Through emergency management, we try to avoid disasters, to minimize the impacts of those we cannot avoid, to prepare for those we anticipate, and to enhance recovery from those that occur.

The NII can be used to significantly improve all levels (Federal, State, and local) and phases (mitigation, preparedness, response, and recovery) of emergency management. The NII can allow emergency managers to make quantum improvements in the management of disasters and emergency response. As a report of the National Academy of Public Administration notes, "Emergency management requires coordination of a wide range of organizations and activities, public and private."[2] Emergency management, whether it is at a national level, in a State like California's Office of Emergency Services, in a local office such as the Dade County emergency management office or the local volunteer fire department in Bay Saint Louis, Mississippi, is crucial to the well-being of this Nation.

After Hurricane Andrew struck the Homestead area, there were places where it was difficult to tell where streets were supposed to run, or tell where houses used to sit. One senior emergency manager described the area as looking like an atomic bomb, without radiation or fire, had hit the area. This potential for the destruction of infrastructure after a disaster is one of the things that differentiates information systems for emergency management from other information systems supporting other functions. Emergency managers must have dependable information systems with backup systems which can be used reliably after a disaster.

The improved use of information technology tools, through the implementation of the NII, will greatly improve the capabilities of emergency managers to coordinate and disseminate vital emergency communications. With each disaster, we are witnessing an increase in information technologies and communications tools used during the response to emergencies. By example, during the Northridge, California earthquake of January 1994 (which had minimal impact on the telecommunications infrastructure) most response systems were in place, within the first several hours: broadcast stations were providing coverage of the situation; fire, search and rescue teams were coping with aftershocks; and emergency responders were already planning the response and implementing previously prepared plans. Citizens made excellent use of cellular phones, faxes, Internet, amateur radios and other communications links to disseminate information and stay in contact with loved ones. Because of the sophistication of telecommunications and coordinated efforts of disaster teams, response systems proved to be effective.

The monetary costs of disasters are very high. While total figures of federal, state, local, and private expenditures are not available, one can get an idea of the scope of the problem from Table 2. This table shows the Federal Emergency Management Agency's (FEMA) expenditures on disasters over the last few years. The table does not show all Federal expenditures (budget processes make it difficult to roll up all expenditures on all disasters). The FEMA expenditures are the bulk of Federal spending in most disasters since FEMA administers the President's Disaster Relief Fund. Table 3 shows the total projected Federal expenditures, through September 30, 1994, for four major disasters.

Table 2. FEMA Expenditures on Disasters.

Fiscal Year	Number of Presidential Declarations	Federal Expenditure (in Billions of Dollars)
1988	32	189.6
1989	30	138.5
1990	39	2026.2
1991	41	391.5
1992	55	1725.5
1993	65	2467.9
1994 (up to 6/7/94)	26	3081.4
Totals	288	10020.6
Average	40	1428.8

Table 3. Federal Disaster Expenditures

Disaster Incidents	Declaration Date	Projected Federal Expenditure Through 09/20/94 (in Millions of Dollars)
Hurricane Andrew	August 1992	3937.1
Hurricane Iniki	September 1992	554.2
Midwest Floods	Summer 1993	6011.7
Northridge Earthquake	January 1994	3,714.6*

** Note that this column represents expeditures through 09/30/94 and some, especially in the case of Northridge Earthquake, will increase.*

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From the tables above, it is clear that the Federal Government expends a great deal on disasters. And yet, the Federal Government's expenditures often are not even half of the total cost associated with a disaster. For example total Federal expenditures for Hurricane Andrew will reach approximately $3,937,100,000 by September 30, 1994 while the total damage is estimated at over $20 billion. The difference represents the amount spent from state, local and private funds. If use of the NII was able to improve information/technologies that support emergency management the net effect could result in a 1% reduction in expenditures, the result would be savings of tens of millions of dollars. It is easy to believe that any improved communications and information systems infrastructure would be of benefit in saving lives, reducing injuries, and diminishing property damage.

Looking at disasters such as Hurricane Andrew clearly show the problems that exist today. Hurricane Andrew to date has been the most costly natural disaster in U.S. history.[3] Difficult areas that lead to problems have included insufficient mitigation, public training, and preparation. The government was criticized for its slow response. People in low-income areas, trailers, and remote areas were not aware of what to do, and could not in some cases be evacuated effectively. However, although recovery and clean-up were slow at the outset, they did pick up later. Better preparations and communications links could have saved property. The same was true when Hurricane Iniki devastated Hawaii.

The Midwest floods, on the other hand, allowed more preparation time because it took longer to manifest itself. While evacuations were effective. it could have also benefited from better mitigation, more planning, and improved environmental engineering. Communities in the flood region were credited with having a collective positive response to the disaster including sandbagging efforts, and the donation of money. The role of the community in working toward maximizing its own safety was remarkable.[4]

While there is a general agreement that the government must have a role in emergency management of disasters, there is growing concern to find a better approach in responding to emergencies. In the U.S. Congress, more than 13 Senators and nearly 100 members of the House have sponsored bills that address either the issue of disaster response or the funding surrounding it. Jack Weber, of the National Disaster Coalition presented one viewpoint on why disasters are so expensive when he said, "Our nation's response to disasters continues to be a reactive one. We wait for our worst fears to be realized, and then we figure out how best to pick up the pieces. It is the most expensive, least efficient and least humane way of approaching the problem."[5]

On the international front, activity continues to grow regarding emergency management, particularly as it relates to issues of disaster reduction and mitigation. A primary impetus has been the 1990 initiative by the United Nations to exchange information by creating the International Decade for Natural Disaster Reduction (IDNDR). In May of 1994 they convened in Yokohama, Japan to review the progress among member states. As a result an impressive array of case studies, research activities, and advice was gathered and published in Facing the Challenge.[6]

One result of the meetings has been the U.S. decision to place more emphasis internationally on prevention, mitigation, and preparedness activities. Clearly this approach would greatly assist developing countries which, according to the report, suffer the most debilitating effects in natural disasters and where disasters cause more than 95% of deaths in those countries. Currently, the United States is working with a number of countries such as Costa Rica, Ecuador, Japan, and the Caribbean nations to develop a variety of projects that will increase the success of managing natural disasters.[7] Improved infrastructures for communications such as the Caribbean Satellite Network would increase the chances of saving lives, reducing injuries, and decreasing property losses.

Third world countries are not the only areas where concern for improved communications links during emergencies is prevalent. Britain has been without a national warning system for some time, creating concern among many officials. "Today's concerns are not flying bombs, but flooding, nuclear accidents, perhaps even...terrorists. People should also be warned if hazardous materials were being transported through their area...Many people would not be aware of a disaster affecting their area under the Government's policy...this could be done comparatively cheaply using the latest technology...co-ordination between different parts of the country is essential to prevent a national disaster."[8]

The National Institute for Urban Search and Rescue established some guidelines for a national crisis information center architecture. These include:

- Deliver the Right information
- To the Right People
- Within the "action "cycle"
- To save the Greatest Number of Lives

These guidelines provide a good framework to describe what functionalities will be required of our information system and how the implementation of the NII will help us successfully get to where we need to be. While NII will add many functional capabilities, it also will assist us in solving the problems associated with some that already exist. Current solutions often are in the wrong place, unknown, or unavailable to emergency managers and the general public.

PART II: Where are we now?

Lately, disasters appear to be occurring on a more frequent basis than during previous years. Emergency managers need a similar rate of availability and capability in information technology tools to prepare for and respond to the increasing frequency and scope of disasters. While recent major disasters are memorable, the increased rate of occurrence of disasters is remarkable. Disasters in the 80's were nearly twice as frequent as disasters in the 70's. In the last 2 years alone, we have experienced (a) the largest earthquake in modern California experience, (b) the most costly hurricane in history and the strongest in decades, (c) a Midwest flood which exceeded the once in every 500 years flood levels, and (d) one of the most devastating and widespread ice/snow storms in the century. According to some weather forecasters, the country has entered a period of extremely destructive weather patterns.

Emergency managers utilize information technology-based systems to augment their efforts. Many of these, however, are cumbersome and/or unable to fully meet the needs of the emergency managers. Implementation of the NII will enhance systems and the ability to use them. Currently, there exist many databases with information addressing most of the different phases of emergency management. But in many cases, queries are still originated and received on paper. For example, there is a fire incident database with information of fires that have occurred all across the nation. To query data from it, a written request is made which results in a batch run against the data base. The printouts generated are mailed to the requester. With the NII infrastructure in place, a fire chief in some small town twenty miles north of Cut Bank, Montana, would have direct online access to this (and other) emergency management data that better equip the local emergency managers to perform their life saving jobs.

Warning Systems

The National Warning System (NAWAS) is a communications system originally designed and implemented in the 1950's as a means of notifying and preparing for a nuclear attack. Fortunately the system was never used for its intended purpose, but has proven invaluable to local emergency managers responding to or coping with natural disasters. Today, the system consists of what is effectively a 2200+ telephone party line. Obviously, it is more than a normal telephone system. The phone instruments are designed to provide protection for lightening strikes so they may be used during storms. The interconnecting lines are provided some protection and avoid local telephone switches. This ensures they are available even when the

local system is down or overloaded. The system is used by local officials thousands of times a year for emergency management coordination and response. One typical scenario is the use of the system during tornadoes. As storms are sighted, emergency managers in one town or county can communicate with their colleagues in other counties who are in the path of the storm, advising them as to direction, speed, and intensity. The drawback to this system is it relies on human intervention. If there is no one there to receive the communications the warning is not disseminated. This has resulted in missed tornado warnings. Today modernization and automation are planned in most telecommunications systems.

As a National Weather Service white paper states, this is a systemic problem. "There is a growing concern that the communication revolution with all its capability, is at the same time isolating the public from locally issued warnings. While the figures vary slightly depending on the source, around 30% of all radio and television stations are automated or remote via satellite; 65% of all homes are connected to cable television with little or no local programming; and 80% of homes have a video cassette recorder and/or video games connected to their sets. All theses situations limit the public's access to hazardous event information."[9] Once again, emergency planning is looking to address improved public awareness of emergencies.

The National Weather Service has expressed a great deal of interest in upgrading the Emergency Broadcast System (EBS), since weather-related incidents comprise about 85% of the activations of the system. The current system requires several steps before the alert can be sent. In some instances, such as a tornado, getting the message in and out of the process exceeds the life-span of the tornado.

Emergency Broadcast System

In 1951, President Truman established the first national alerting system called CONELRAD (Control of Electromagnetic Radiation) to broadcast on 640 or 1240 kHz during an emergency alert to the public so enemy missiles could not use transmission from broadcast stations as a guide for their targets. By the early 1960's the development of missile guidance systems made the CONELRAD system obsolete. In 1963, President Kennedy established the EBS which was later further expanded through an interagency effort with the FCC, FEMA and the National Weather Service (NWS), to permit the system to be used for state and local emergencies. Since that time, generations of Americans, while watching television or listening to the radio, have been suddenly interrupted by an obnoxious tone that is followed by the familiar phrase "This is a test of the Emergency Broadcast System. If this had been an actual emergency... ." While this message was intended to save lives, studies show the public has become desensitized to the weekly EBS test. So what happens when there is a real emergency? Too frequently, nothing.

Since 1989, the Federal Communications Commission (FCC) has been conducting a serious evaluation of the over 40-year-old EBS. After all, the threat of nuclear attack is no longer as strong. Mostly, it is used to communicate pending natural disaster warnings. Each year the FCC receives more than 2000 notices of EBS activation for disasters like tornadoes, flash floods and man-made occurrences such as chemical spills.

While the current system can be effective if your television or radio is turned on, unfortunately emergencies do not always happen at such convenient times. A new system to replace EBS is being developed by the FCC in cooperation with FEMA, NOAA, and the White House Communications Agency that will maximize the avenues available on the NII to provide instantaneous emergency information to the public.

Most recently in March 1994, Vice President Gore addressed a new initiative of the Administration to provide early warning information to the public. The NOAA Weather Radio and other emergency systems such as EBS which were designed to upgrade emergency communications were part of this "All

Hazards" approach to providing information which will open an important link into the NII.

Preparation and Response Systems

When a disaster does occur, the type and level of response to it depends on the size and nature of the disaster. Most disasters are handled at the local or State level. If a disaster requires Federal response, it comes from various Agencies each with main and supporting roles. The Federal Emergency Management Agency is responsible for coordinating Federal response to most disasters.

In a Federal response, typically, a Disaster Field Office (DFO) is established in the disaster area with one or more disaster assistance centers, The DFO is the central federal coordinating facility for the disaster and is staffed with representatives from many different Federal Departments and Agencies. Numerous information systems support these federal responders. Initially, transportable communications are used if the local communication infrastructure is unavailable. Information systems include local area networks and other stand alone systems. Disaster victims apply for assistance from one or more Federal, State, or local agencies either in person or by phone through a teleregistration process. This application processing can be lengthy, and in a major disaster it can require hours of waiting in one line after another. Application for the various assistance programs is usually done separately, once an applicant figures out which if any program he or she is eligible for. The Teleregistration process was instituted by FEMA to reduce some of that waiting time.

Emergency management education is handled through many different processes. From Federal level, the primary processes for delivering of this education is done through on-site training courses and correspondence courses. While effective, these training efforts could be enhanced through more automated efforts. Automation will require not only automating the means of delivery (the source of the training), but also significant improvements will be needed in the communications links and systems on the receiving end.

The 23 members of the National Communications System (NCS) are Federal departments and agencies that work together to achieve interoperable communications on the Federal level. Originally chartered to ensure the availability of communications to Federal officials in times of disasters or significant stress on public communications systems, the members of the NCS are currently also concerned with the availability of communications during disasters and the restoration of public communications after a disaster occurs.

The General Services Administration (GSA) Regional Emergency Communications Coordinators participate in disaster recovery operations as the NCS on-site coordinator. FEMA, other Federal, State and local agencies, and the American Red Cross must have telecommunications to begin disaster recovery operations. FEMA in particular generally supplies its own communications infrastructure during initial response efforts due to possible unavailability of public systems. GSA coordinates with the telecommunication vendors assuring that the public telephone network is restored and trunks, lines, data and facsimile transmissions, switches, radio equipment, and other portable telecommunication equipment is available and operational. They make rearrangements for telecommunication services when systems become overloaded.

Highly reliable and available communications in and after disasters is provided by a High Frequency (HF) radio system when other systems are damaged or destroyed. The HF radios are commonly available in all Federal agencies, in regional offices, and in State emergency centers. They are also used in disaster response when other communications systems are not available. For example, for the first 24 hours, HF radio deployed by the Federal Emergency Management Agency (FEMA), was the only means of off-island communications after the recent hurricane struck the Virgin Islands. HF radios are considered a backup to other media due to the relatively slow data rate and other limitations.

In some cases communications and information systems lack compatibility and interoperability.

Overcoming these types of problems and providing enhanced capabilities as well as functionality will directly improve emergency management systems.

PART III: Where do we want to be?

Just as the personal computer revolutionized the computer industry, the NII will revolutionize emergency management. We can foresee some of the implications, but once in place, the user community will explore, expand, and develop radical enhancements and improvements we do not even foresee. It is obvious that the NII will result in vast improvements in the information support of emergency management and the integration of emergency managers and their processes. Identifying short term goals offers fertile examples upon which we can build an infrastructure that exploits currently available technologies.

The foundation in preparedness is planning how to handle the disaster. The art of perfecting how to respond to disasters is enhanced by the ability to bring together the key players for periodic exercises which simulate actual disaster. These simulations can be just desktop programs or more realistic reinactments that serve to clarify who does what and how to get it done, and resolves the handling of a wide range of problems. The implementation of the NII will result in dramatic enhancements in the information systems used in these simulations.

Accessibility

The measure of our Nation's success in implementing the NII will include measuring the ability of the volunteer fire chief or other emergency manager, in a small town somewhere in the nation, to use the NII in serving the public. For this to occur, we must ensure the NII is not just an entertainment-oriented network of limited "upstream" operational capabilities. It must incorporate bidirectional high speed networking capabilities that support the needs of the of the on-the-scene local emergency managers.

Ease of Use

To meet the needs of the public and the emergency management community, the implementation of NII must include a user interface that is multilingual, and designed for use by individuals of varying educational levels, skills, and abilities. According to reports of the Department of Labor, there will be a substantial increase in minorities, immigrants and women entering the workforce by the year 2000.[10] Immigrants will represent the largest share of the increase in population, more than 600,000 annually. For many it will be the first exposure to English.

It is essential that ease of use, by many different types of people, be a design criteria for most information systems supporting emergencies. Emergency management, including public alerting systems, must be broadbased enough to service an English speaking as well as non-English speaking public. This public also includes, and the system must support, persons with a wide spectrum of disabilities. A system that supports only English speaking, computer-literate consumers will fail to meet the requirements of the citizens and the emergency managers who support them.

During emergency situations, there is no time to learn. People are excited, worried, and/or confused. A hazardous material response team from a small town fire department needs a system that provides easy access (on a random, probably infrequent basis) without a learning curve or the need to recall intricate access methods. Similarly, an earthquake victim who speaks and reads only Spanish will find an English-only system useless. Fortunately, this need for multicultural, multilingual, easy access systems is something that fits into exactly what the NII can provide. It simply needs to be a design criteria for the user interface.

Survivability

The NII must include protection to ensure that service continues to be available even in the most adverse conditions. Growth in the dependence on NII capabilities will require those capabilities be available in times of emergencies when some key elements of the infrastructure may be damaged or destroyed. Currently, a hurricane or other windstorm almost always renders the existing cellular telephone systems unusable due to downed antennas. Land-line based telephone systems may or may not be available. During earthquakes, the same system outages may occur. Following the Loma Prieta earthquake, the only dependable telephone connections between Washington disaster response centers and the San Francisco area were via an emergency telephone system which bypasses the public switched telephone network (PSTN). In this case, the local PSTN was to some degree operable, but it was overloaded by the public trying to contact friends and relatives to determine or relay their safe being.

Some portions of an infrastructure are more likely to survive a disaster than others. As noted earlier, high frequency radios such as those used in many emergency centers or by amateur radio operators or even citizens band radios are often operational after a severe storm (possibly running on backup power). But these systems are severely limited in their ability to pass large amounts of data in a timely fashion and as a result can provide voice communications but can not support many of the other requirements of emergency managers responding to a disaster.

Public Support

The availability and capabilities of information tools and systems to the public will be enhanced through the NII. The public will both have better access to data, easier communications with emergency management officials, and will be better served by the emergency managers responsible for disaster mitigation, preparation, education, and response. Through the NII the public will have the ability to electronically obtain public awareness information as well as receiving warnings of impending disasters. Emergency responders will be equipped to support the public through many improvements brought about by the NII including better training in more realistic simulations and exercises.

Emergency Managers/Responders Support

Emergency managers and other front line responders have unique requirements for information accessibility and dissemination which will also be enhanced through the use of the NII. In this area, the capabilities of the NII to move, display, and analyze data will significantly enhance the emergency manager's ability to provide assistance to the public and other emergency managers. The high speed data transfer available through the NII will supply significantly increased functions to local emergency managers including allowing them direct access to modeling, situation assessment data, public and private data repositories, multimedia simulations for training sessions, and many other functions.

Following are some examples of specific problems and potential NII solutions. While the public and the emergency management community all benefit from any of the improvements available through the NII, the example benefits can be grouped into 3 logical groups. These three categories are: within the emergency management community, from the emergency management community to the public, and from the public to the emergency management community.

Within the Emergency Management Community

Problem — access to and delivery of training. Training of emergency managers and the general public is essential to emergency management programs. Today, training materials are generally developed by emergency managers at all levels who have limited access to other sources of emergency management data. While data supporting their efforts may exist in many places, knowledge of and access to the data is often on a haphazard basis.

- **Possible NII-driven solution.** Using NII tools, emergency management will have a greatly improved ability to obtain "distance learning" training directly to their localities. This training will have the added impact and effectiveness with the capabilities NII will provide. Interactive, multimedia training with high speed computer-based models will provide realistic and real-time training scenarios. Given the opportunity to acquire knowledge through exposure to various computer models, emergency managers will be better able to help the public.

Problem — common access and understanding of data. The public and emergency managers currently have access to some types of emergency management data but not all users have the tools and communications links to achieve that access. In addition, there often is confusion in terminology.

- **Possible NII-driven solution.** Implementation of the NII can provide the access path and resource components for a data repository of emergency management information; in effect, an online data dictionary and textual database for emergency management. Now all levels of emergency managers and the public will have equal access to information and its relationships. This repository will allow any emergency manager or any public citizen easy access to emergency management data and the relationships between the data. A local manager will have the ability to quickly find out the details behind a particular emergency management term or technique. Additionally, as an easily accessed repository via the NII, the user will also be in a position to do key word searches throughout emergency management publications. With this ability a local user can easily understand how a term is used in relationship to a grant application or a required report.

Problem — shortage of and limited access to computer-base modeling for mitigation purposes. Historically, lack of early simulation and projection have cost our communities loss of human life and property. Today, lack of applying disaster simulation to current communities may cost us loss of property and lives tomorrow. Currently, computer modeling capabilities for mitigation purposes exist to some degree. However, the models are limited and are generally unavailable to local emergency managers. The significant advantages this capability offers in mitigation efforts as well as planning and exercising (i.e., realistic model-driven exercise scenarios) are clear. The gap between modeling capabilities and the Federal, State, and local level emergency management community must be overcome.

- **Possible-NII driven solution.** Access to and availability of natural disaster computer models and the resources required to run them with different potential scenarios would be invaluable to local Emergency Managers. This capability would allow local officials to run tests and exercises based on real life expectations of damage It would support other local officials by allowing them to automate planning and zoning studies through model projections of the potential for floods and/or the impacts of storm surges in defining "no build" locations. Earthquake or flood prone locations will have increased ability to do such things as modeling of impacts on public structures or evaluating and testing various architectural plans prior to construction. Positioning of facilities needing special care during a disaster could also be studied prior to construction providing an opportunity to evaluate various location in the areas of potential damage as well as evacuation processes.

  The ability to have quick evaluations produced and delivered to the local official's desk will enable more extensive and more frequent evaluations, thus reducing construction or planning delays. Implementation of the NII will support the mixed use of emergency management automated tools enhancing local decision making as well as avoiding costly mistakes on locating and positioning facilities.

Problem — access to disaster data as it is occurring. During, or in preparation for, emergency response efforts, emergency

managers need to share and collaborate on varying types of information. Multimedia interactive sharing across thousands of miles (as opposed to a local area network) will allow better preparation for disasters and enhanced training of Emergency Managers.

To explore one of the problems of local emergency managers and how the NII will help them, take an imaginary (but very potentially real) scenario. A hurricane is tracking directly towards Sussex County, Delaware. With data on the strength of the storm, other climatic information, and track predictions, high-speed computers could run models to predict several different impact scenarios. Given a fast computer and communications links, good models and input data could allow local emergency managers to determine potential requirements for evacuations based on potential wind strengths. The state and local emergency managers have many decisions to make prior to landfall. For example: What will be the storm's impact? Do we evacuate? Total evacuation or partial (i.e., possibly just residents of trailer homes or only those directly on the waterfront)? If so, what routes will be safe and where do we send the people for safety? If evacuations are ordered are there special populations (hospitals, nursing homes, prisons) in the danger area needing special assistance to evacuate?

- **Possible NII-driven Solution.** Currently many questions on preparedness can be addressed, but the answers are not available when and where they are needed in the State and local offices. What's missing is the infrastructure that will result from implementation of the NII. With an infrastructure in place, storm strength and track data is collected, photographic images, and computer-generated images could be quickly and easily transmitted to the State and local officials (as well as any Federal officials on site). Access to census data, integrated with geographic information, could identify special populations in any threat zone as well as indicate overall evacuation populations and the potential impact on evacuation routes. Wind damage estimates also coupled with the census data could identify communities under special threat (i.e., trailer parks). Using the NII we will have a system which provides an integration and delivery of the data and the answers to the people making the decisions .

Problem — limitations in sharing experiences in disaster preparation and response. Federal, State, and especially local Emergency Managers need access to existing data and new sources of data. On one hand, there is a great deal of existing data. As noted before, one problem with this data is that its existence is not well publicized (an educational issue). A second problem is simply providing access. A third problem is that much data is not correlated with other data and, even with the existing data, additional data sources for Emergency Managers are needed.

- **Possible NII-driven solution**. From a data standpoint, several actions are required. Access to existing data sources could be made easier and integrated. As this effort is undertaken, additional requirements for new data repositories will be identified. For example, a lessons learned database for emergency managers (including front line response personnel) could be evolved out of existing systems with added data fields and sources.

Problem — accessing damage for initial assessments. Information technology is currently used in many different ways to support emergency management. One important area is in coordinating response efforts. Done in the "heat of battle" emergency response requires quick, decisive action. That action must be coordinated among different responders (the number and type depending on the circumstances and type of disaster). While we have made progress, the GAO noted a significant problem: "The coordination problems and lack of timely damage assessment reports delayed the federal response to storm victims."[11]

- **Possible NII-driven solution.** The emergency management community has made improvements since that report. However, the NII will provide the opportunity for quantum improvements in the ability to

coordinate emergency response information dissemination, and the gathering, transmission, and interpretation of damage assessments. With the implementation of the NII infrastructure and next generation computers and virtual imagery, an Emergency Management official responsible for assessing damage and planning response effort will be able to "virtually" walk/drive/fly around a disaster scene gathering data, planning the response effort, and starting the delivery of the appropriate type and level of assistance.

In some instances, implementation of the NII by itself, will have no impact on emergency management. However, merger of NII and other technologies will provide tremendous improvements in emergency management and public safety. As described earlier, in the aftermath of some disasters, many core elements of the infrastructure will be inoperable.

Problem — lack of ground communications after a disaster. On August 24, 1992, Hurricane Andrew struck the southeastern Florida coast. Within hours the worst of the storm had moved on, leaving much of the information infrastructure in shambles. "Communications in the south Florida area were severely damaged..... Nearly all cellular base station towers in the area had been blown down or damaged to the point of being inoperable."[12] On top of this damage, many surface-based phone posts and lines were down, seriously reducing normal telephone communications capabilities. Any strong storm with high winds is going to seriously disrupt communications, reducing the effectiveness of emergency management responders as well as exposing the public to potential health and safety problems if they are unable to contact police, fire, and medical support.

- **Possible NII-driven solution.** The technology and interconnectivity coming out of the NII implementation will be coupled with current research and development in producing a product to meet our needs. A small drone aircraft with the capability to stay aloft for 3-4 days hovering in a tight circle could be equipped with very high speed computers (acting as switching equipment) and updated radio equipment. The equipment will provide a mobile cellular system. The aircraft will have staying power, and will allow the cellular system to be positioned high enough to service a wide area. We would have a rapid temporary replacement cellular phone service. (A potential alternative or complementary technology could be low orbit satellite communications as that technology emerges.)

Problem - up-to-the-minute fire status and predictions. Lives have been lost and unnecessary property damage done because weather information, such as wind velocity and direction, and fire spread patterns have been inaccessible to the fire fighting unit. Early evacuation and creating fire breaks could have been done had the appropriate information been accessible in the field with the fire unit. The similar but unique requirements of a fire fighting unit can be met by implementing the NII infrastructure.

- **Possible NII-driven solution.** With the NII, a fire unit fighting large wide-spread fires, such as last years devastating fires in southern California, could call up a computer model to generate an up-to-the-minute fire spread prediction. Fire spread projections overlaid on GIS maps could be visually displayed right in the on-the-scene fire fighting vehicle allowing better utilization of the resources and warning of possible fire spread which cuts off evacuation routes from the scene.

Problem — quick access to data and computer models for first line responders. Crews responding to hazardous material spills have their own set of unique requirements. Although there are existing databases of hazardous materials and how to handle them, crews do not have on-site, on-line access to such data. Simulation tools, allowing for chemical compound modelling and associated affects of chemical mixing, are not currently employed. Often emergency on-site crews are not aware of the full toxicities, vapor drift and

dispersion projections, and other associated dangers when responding to a hazardous chemical emergency.

- **Possible NII-driven solution**. Using the facilities of the NII and possibly high speed computers under the HPCC effort, a HazMat responder could quickly access automated chemical models. With that access, the responder could obtain the models prediction of the effects of the interaction of the chemicals, how to respond to the incident, toxicity, vapor drift projections, and best cleanup methods. These enhancements will reduce physical risk to the responders, increase their effectiveness, and improve the safety of the public.

From the Emergency Management Community to the Public

Problem — government presents many faces to disaster victims. Following a disaster, there are numerous Federal programs designed to assist the public recover from the impact. Some of these programs are simply day-to-day support such as food and housing, others are designed to assist in recovery efforts, while other programs are low interest loans to rebuild small businesses. In a time of confusion resulting from the disaster, the public is faced with numerous programs for which they may or may not qualify, from various different Federal offices, with different application and qualification requirements. This is a Federal Government attempting to assist, yet presenting a confusing and frustrating face to the public.

- **Possible NII-driven solution.** The obvious solution to this problem is to present one unified face to the public. That solution has been talked about for years as Federal Government reorganization plans are developed and redeveloped. Part of the problem is that certain programs seem better positioned (and executed) in different agencies, and the consolidation would require moving major programs from one agency to another. A solution that allows this integration without reorganization is provided by the NII. The NII will allow integration of the presentation of programs, application for them, and evaluation of eligibility for disaster support programs provided across the Federal Government; the result, a virtual Federal disaster assistance agency.

Problem — dissemination of emergency information. One problem in any disaster is getting information to the emergency managers as well as the public. Often different technologies are used for these different requirements due to the differences in need. In general there lacks sufficient low cost capability to get extensive amounts of data to either of the groups. For the emergency managers, speed, quantity of data, varied media (text, digital, video, and audio), and the integration of the data dictate delivery requirements. For the public, speed and duration of the data being provided direct the delivery requirements. Immediately before a disaster, the public needs warning messages. After the disaster, recovery information such as where to locate resources, what response and recovery actions are underway, and how to apply for and get assistance needs to be conveyed.

- **Possible NII-driven solution**. Another example of merging the results of implementing the NII with other technologies involves dissemination of emergency management information to the public as well as emergency managers. With the NII infrastructure in place, direct delivery of broadcast messages can be aimed at a selected set of receivers. Examples of this include the ability of Emergency management public affairs officers to transmit public information (i.e., locations of disaster assistance centers, or precautions to take before reentering a damaged structure) via satellite to cable TV head ends and other broadcast media for use as scroll bars on the bottom of TV images. Another use would be to direct imagery or other large data formats to local emergency management officials preparing for, or involved in, responding to a disaster.

BEST COPY AVAILABLE

Problem - ensure the public receives warnings and takes appropriate action. Often people are at risk of an impending disaster and are unaware of warnings being broadcast by emergency managers. Even if the emergency managers were transmitting a life saving message, unless the public was actively seeking information, they would still be unaware of the pending danger. Most warning systems are not generally self-activated.

- **Possible NII-driven solution**. The NII, through the cooperative efforts of Federal agencies, will have the ability to reach people that are at risk without those people actively seeking information. Information will be provided instantaneously and clearly to the targeted population, and inform them where to go for more in-depth information. Major improvements will include a new generation of EBS equipment that has the capability of interacting with cable and other communications technologies to take a proactive role in alerting the public to immediate danger.

  Imagine, you are enjoying an evening with friends, listening to the latest CD when suddenly a loud series of warning tones cuts off your CD and turns on your cable TV to a message that advises, "A tornado will hit your area in three minutes. Take cover." You and your friends take protective action in time to save your lives. A wide range of enhanced emergency alerting equipment is in prototype now, that could bring about this positive scenario. Testing has shown that the proposed new generation of equipment in the public and private sector will offer more than 30 options to the consumer that can turn-on and turn-off consumer alerting equipment such as personal pagers, cable television sets, CD players, VCRs, television and radio receivers, car radios and emergency detectors with a barrage of beeps, buzzes, strobes, sirens, audio messages, video crawls and other appropriate alerting sights and sounds that will make each equipment unique for its user. Systems for the visually impaired, deaf, hard-of-hearing, and bilingual audiences will also benefit from equipment that serves everyone equally. That same equipment will provide emergency information — within a matter of seconds — to a home, a hospital, a neighborhood or the entire county or state. Federal, State, and local government emergency communications centers, television and radio stations, cable facilities, and satellite and mobile systems will transmit and receive specific emergency alerts in a reliable competitive environment that promotes maximum safety to the public. This planned use of the NII will serve the nation into the next century.

From the Public to the Emergency Management Community

Problem -- verification of victim eligibility. When a disaster victim applies for assistance, that person/family must meet certain criteria. For instance, to obtain assistance in repairing a home, the applicant must be the owner of the home. For some programs, the applicant must demonstrate an income which is less than an established cutoff level. Unfortunately, as described previously, some disasters are so extensive and destructive and some times papers providing such simple proofs are no longer available.

- **Possible NII-driven solution**. Efforts under the NII, specifically establishing an electronic government, could be expanded to allow disaster application centers direct access to selected government data bases. Data supporting the necessary verifications currently exist in government data bases. For instance, an applicant with nothing more than a driver's license or some other acceptable ID could walk up to an application taker and provide whatever information is available, i.e., home location. The application processor through NII-provided access to VA and HUD home loan databases or local property tax roles, could verify home ownership. Or, a citizen could authorize access to social security or IRS data bases to verify income and rapidly determine the applicant's qualification for income-based assistance. Access to State

and local data will also enhance the delivery of emergency management to the public. Electronic verification and qualification of a disaster victim using existing government data will speed up and improve our efficiency in direct support of the victims.

PART IV: How are we going to get there?

There are various avenues that can speed the implementation of the NII and its effectiveness within the emergency management community. There are also accompanying questions that once discussed will assure those contributions will have a lasting impact.

Even after access to on-line emergency management information is made easier, there is a lack of access tools in the hands of the front line emergency responders. To reach an acceptable level of success, computers with access to the NII must reside in every local emergency management facility. For example, each of the over 30,000 separate fire departments in the United States need an access point, so does each state and local emergency management office. There is a separate NII requirement which complements this "need of access" from the emergency management facilities. This is the requirement to provide universal accessibility to the public. A merger of these requirements could result in access to the NII and enhance the relationships between local emergency management officials and the local community. The question for discussion is then, Should access points be established in local fire or police departments serving the emergency responders as well as should access points be established for members of the local community who do not have their own access?

The problems associated with making insurance company data available to emergency managers need to be resolved. There are conflicting issues here, business sensitive data versus emergency management requisite for data, which need to be in order to facilitate emergency processes and decision making. There should be some compromise position that meets both requirements. The question for discussion is, Should emergency managers have access to insurance data including loss data to assist them in assessing the potential impact from or actual loss due to a disaster?

Fire, police, and other health and safety personnel need the ability to locate people who have summoned aid, but are for whatever reason, unable to communicate their location. Telephone systems have the ability to trace back phone calls that can be of great use in responding to a land- line generated request for assistance. Cellular systems have a similar but unused capability, while not providing specific information they can at minimum identify the cell originating the call. The question for discussion is, What, if any, action should be initiated to require cellular providers to provide call tracing capabilities for emergency responders?

The Federal Government could achieve improved efficiency through the use of the virtual agency concept to eliminate redundant systems from multiple agencies. The GITS efforts on the interconnection of Federal agencies should help achieve this. In the mode of streamlining government, one Federal agency could be tasked with the responsibility for emergency management information systems. This would consolidate interoperable (Federal, State and local) systems which provide similar methods of access and use. Reduction in conflicting and overlapping systems would provide obvious benefits. By example, the NII would be better able to energize the delivery of emergency communications and maximize the effectiveness of emergency managers. The larger question then becomes, To what extent should information systems be integrated under one agency and to what extent should various departments or agencies still remain responsible for different types of disasters?

One of the keys to successfully implementing the NII to improve emergency management is the use of multiple technologies. Using similar technologies and multiple technologies often allows for more avenues of communications to be accessible during emergencies. As an example, some questions have been raised

regarding the need for modernizing the EBS in lieu of a more widespread use of, and expansion of the NWS, NOAA Weather Radio network. EBS and NWR are complementary systems serving different audiences and needs. The EBS provides an initial alerting function to the public, while the NWR provides extensive follow up information. The question is, Does a lack of technology aid or detract from the on-scene responder's ability to reduce the complexities imposed on state and local emergency managers?

There are also some technologies under investigation which are unrelated to information technologies, but could directly or indirectly support emergency management functions. They include: NASA's research on small pilotless drones with extended (3-7 days) aloft time; the ARPA and HPCC miniaturization and high speed efforts; and the DOD research into the use of satellites for direct, selected delivery of information to ground base systems. The question is, To what extent should the emergency management community monitor these types of activities to ensure such research and development efforts consider emergency management requirements and potential use?

A critical discussion point on how are we going to get there must be centered on what action comes next. Is the action developmental, such as when or if a common system should be built; or is it implementation-oriented, such as who should lead the discussion on integrating the NII within the emergency management community? The larger question then becomes, Should the Federal Government assume the lead in forming partnerships with state and local emergency managers and independent associations of emergency managers? If so, Should these partnerships address integration, dissemination, and access to data sources across all levels (Federal, State and local) and phases (mitigation, preparation and training, response, and recovery) of emergency management?

Both at the domestic and international level the knowledge base on emergency communications is growing. Government, scholars, practitioners, and the public are ever sensitive to the need to maximize the number of solutions that can reduce the loss of life, injuries, and property when natural and manmade disasters strike. Many experts in cross disciplines are finding they can contribute to the field of emergency management when brought together in established or ad hoc situations. According to a leading expert in the field of natural hazards, Dr. Dennis Mileti, "Hazards do not happen in insolation. Therefore, we must work at all levels to maximize the number of participants from various fields working together to expand and share resources and knowledge. The goal must be to ensure societal resiliency and environmental sustainability regardless of the hazard."[13]

The NII can provide the pivotal role in convening a forum comprised of a cross section of experts, both within and outside of government, to explore, integrate, and implement strategies that will strengthen the Emergency Management community and subsequently provide the ultimate public service of saving lives.

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Public Empowerment With Environmental Information

DRAFT FOR PUBLIC COMMENT

PART I: What Is the Application Arena?

Description of Public Empowerment with Environmental Information

The Clinton administration has articulated a vision of enhancing the environment through greater public education and broader dissemination of environmental information. This vision recognizes that the diffusion of useful information is a key strategy for preserving our planet. The information revolution provides new opportunities to empower the public and private sectors to find solutions that provide enormous environmental and economic benefits.

Some aspects of the National Information Infrastructure (NII) will serve as an enabling agent in bringing the vast national investment of observational environmental monitoring data into an integrated network for scientific, policy, and operational uses. Yet, the NII will also disseminate environmental information among the general public, agencies and non-governmental organizations involved in environmental management including industry, environmental groups, landowners, educators, students, and the press. This NII application of empowering the public with environmental information is different than making existing government functions more efficient. It recognizes that information is essential for the public to become active partners with government in protecting the environment.

Every day, people make decisions in the market place and in their ordinary activities that have environmental consequences. By giving people the information necessary to evaluate these consequences, sustainable lifestyles and economic development can emerge. The marketplace and community awareness then help to produce the environmentally beneficial result, complementing government action.

In order to explore the essential role of information in environmental management, we will first discuss the role of information in such familiar areas as finance, weather, and sports. These topics will be related back to the main topics at hand, ecosystem management and environmental protection.

Finances and Information

All of us have personal finances to manage, and most of us recognize that one's quality of life is affected by one's finances. Now, imagine a situation in which you lack reliable information about your income and your spending. Imagine no payroll statements, no bank statements, no records of checks written and charges made, and so on. Planning would be impossible — at any moment you might be faced with bankruptcy.

Fortunately, most of us don't face this situation. We receive plenty of information about our income and spending. Guesswork should not be necessary. We are not expected to dig for the information — we are only expected to use the information and try to balance our checkbook. We get the information we need to empower us to manage our personal finances, in a form that is convenient, personal, trustworthy, and supported by expert help whenever needed.

Weather and Information

Mark Twain pointed out that although everyone talks about the weather, no one does anything about it. But strictly speaking, that isn't true. When you hear that rain is in the forecast, you may pick up an umbrella or raincoat. If it's supposed to be cold and windy, you wear a warm coat. You respond to current and forecasted weather conditions. You can't change the weather, but you do something about it by reacting, by adapting.

We did something else about the weather by working nationally and internationally to build a weather information infrastructure. Consider how pervasive weather information is. You hear about the weather on the radio. You see it in the newspaper. And television now provides marvelous satellite images and movies, Doppler radar displays, animated graphics, and lively human commentary to explain current conditions and forecasts. Weather is part of every local news show, and nationally we have The Weather Channel™ on cable. Billions of dollars have been spent on the capabilities to gather weather data and generate and disseminate forecasts. Weather satellites and information networks provide global coverage. Thousands of lives have been saved by improved forecasting and warning capabilities, and large economic losses have been avoided through timely responses to better predictions.

The World of Sports Information

Finally, consider sports, another area of pervasive information flows. For most of us, sporting events lack the immediate, direct impacts on our lives of financial situations and weather events. Nonetheless, millions of people are keenly interested in sports, and an elaborate information infrastructure has been built around that interest. Sports information captures large sections of the print media and is inescapable in broadcast media. Sports has its own publications and radio and television networks.

One might ask which came first: the overwhelming interest, or the vast information infrastructure to feed the interest? It may well be that the sheer pervasiveness of sports information elevates sports in American culture in a cycle of positive reinforcement.

PART II: Where Are We Now?

Now let us turn to the environment and ecosystem management. It is obvious that the environment affects our lives in the most fundamental ways possible. Moreover, people are extraordinarily interested in the environment. Recent polls indicate that nearly 80% of Americans call themselves "environmentalists." More Americans visit museums and zoos every year than attend professional sporting events. Tens of millions of Americans enjoy various activities outdoors in our ecosystems: hiking, birding, fishing, hunting, camping, and so on.

Not only is interest keen in the environment, but unlike the weather, we can do something to change it. Sometimes, out of sheer ignorance, we destroy parts of it. Lack of information is the silent partner of the more prominent agents of environmental destruction. We eliminate species like the ivory-billed woodpecker and passenger pigeon. We introduce species like the gypsy moth and zebra mussel. Harmful chemicals are disseminated by human activity and travel across the globe. We cause fisheries to collapse. An unfortunate example is the virtual elimination of the once prolific oyster fishery of the Chesapeake Bay. We destroy hundreds-of-millions of acres of habitat. In the United States, we send millions of tons of topsoil into the rivers every year.

There are endless tales of destructive changes to the environment, but it should be emphasized that we also make positive changes. In the United States, we banned DDT and PCBs in the 1970s. Thanks to the DDT ban, the bald eagle has made an impressive comeback. Today you can even see the eagle flying free again over the Nation's capital. Internationally, we are phasing out the manufacture of CFCs, thereby reducing the threat to the ozone layer. Thousands of Americans engage in volunteer work to clean up beaches and streams, plant trees, count birds, maintain hiking trails, and otherwise help the

environment. Americans are recycling and practicing energy conservation with greater regularity.

In short, unlike the weather, we can do much to change the environment for the better or worse. These positive changes came about through increased public awareness. Given appropriate information, each of us can be empowered to take positive action in our daily lives.

Ecosystem Management and Sustainable Development

The Administration is committed to an ecosystem management approach to the environment and the economy. The concept of ecosystem management explicitly recognizes the linkages between economy and ecology and asserts that it is possible both to promote sustainable development and to protect the environment. Ecosystem management is a vital approach in the pursuit of sustainable development.

Real parallels exist between financial management and ecosystem management. If we don't know what our ecological assets are, we are poorly equipped to safeguard those assets for future generations. If we "spend" too much of the natural outputs and capital of an ecosystem, we see symptoms of impending bankruptcy such as fisheries collapse, endangered species, and loss of jobs. Such deficit-spending-style ecosystem management results in what Secretary Babbitt calls "train wrecks" like the forest and fish crisis in the Pacific Northwest.

Information is equally critical to financial and ecosystem management. Without information, we cannot manage finances at the personal, corporate, or government levels; and without information, we cannot manage personal "backyard," local, or regional ecosystems.

Current State of Environmental Information on NII

We've looked at how pervasive financial, weather, and sports information is in our culture. As the National Information Infrastructure (NII) emerges, we will find all the financial, weather, and sports information we could possibly want, in fact more than we can possibly absorb.

How pervasive is environmental information in our lives today? Consider air pollution as an example. In most U.S. cities you might hear a single number, the air quality index, mentioned once per day for a single air pollutant such as sulfur dioxide. Even though there is an air quality monitoring program in the region with a network of monitoring points, it would take considerable effort to track down the air quality data for the full range of pollutants measured, and it might be impossible to obtain current information.

You won't see an environmental segment on the news with expert commentators and explanatory graphics to tell you about the pollution events of the day. You won't find an environmental channel you can turn to like The Weather Channel™ on cable to find out about environmental conditions and forecasts. You won't hear which companies are doing better and which worse in their environmental programs. You won't see data about habitat loss in your area in the last day, week, month or year.

If you recycle, you may have noticed that it's hard to get basic information about what you can recycle and how to do it. It takes great effort to find information about the best ways to conserve water and energy. A recent U.S. Army Corps of Engineers study found that those most willing to conserve water also reported a lack of information on how to do so.

If you're interested in investing, weather, or sports, you can buy software packages and subscribe to on-line services that will help you get current information and make your own forecasts and models. You can create and follow your own "dream team" for your favorite sport. But similar software and services for the environment are hard to find, if they exist at all.

If the environment were a minor sideshow with little or no impact on our lives, the relative dearth of environmental information wouldn't matter. But try telling the people of the Pacific

Northwest, who have witnessed the simultaneous collapse of their timber economy and their salmon fishery, that the environment is not of major importance. Try telling the former oyster fishermen of the Chesapeake Bay that what happens in the environment is of little importance to their lives.

If the destruction happens gradually enough and invisibly, without galvanizing incidents like the catastrophes of Bhopal and the Exxon Valdez, by the time a threshold is crossed, it is too late to effectively mitigate the consequences. We need to make the gradual, invisible changes visible to people. Financiers and meteorologists know this lesson. Financiers build indicators to track changes that otherwise would be hidden, and meteorologists use sensing technologies to "see" events that can't be seen by the eyes of observers on the ground. And in sports, instant replays help us see what happened when we missed it during the live action.

PART III: Where Do We Want to Be?

New Strategies

To combat harm to the environment, we have relied primarily on command-and-control strategies — regulations to tell people and companies what they must or must not do, and often how to do it, combined with enforcement programs to ensure that the regulations are followed. Command-and-control approaches have worked to improve air and water quality in many respects. However, we are encountering diminishing returns as we seek to use more regulation to make more improvements in environmental quality.

It seems apparent that the American people dislike government telling them what to do and how to do it. The National Performance Review suggests that the Federal Government place greater reliance on empowerment strategies to, in effect, help people do the right thing. Recall that 80% of the public say they are environmentalists. Are there ways to empower them to do more for the environment, to act out what they say?

Information is key to an effective empowerment strategy for the environment. If our nation were to build an environmental information infrastructure comparable in capabilities to the robust information infrastructures we have built for finance, weather, and sports, we could provide people with environmental information to empower them. This kind of empowerment would work the same way that financial information and forecasts empower us to make informed choices in our financial management; weather forecasts empower us to prepare for the weather, and sports coverage empower us to feel strong emotional involvement with sporting events.

Humans can and do affect the environment. Our robust weather information infrastructure follows a linear "observe-forecast-warn-react" model. This works quite well for the weather, since we can't practically change it and can only react to it. But this model is too limited for the environment, where the relationship is more complex — the environment changes us, but we also change the environment.

We need to follow a "feedback" model that acknowledges the feedbacks between humans, information, and our environment. In a feedback situation, information flows can influence human behavior, and the new behavior changes the environment. This kind of feedback also applies to financial markets. Responses to information about actual events and rumors can cause waves of buying or panic selling, moving prices up and down. Analysts know that there is a highly dynamic feedback process between information and markets. We need to apply this same insight to information and ecosystems.

In this feedback model, information has a fundamental influence on human behavior that affects the environment. Our ecosystem management initiatives can succeed only to the extent that we treat environmental information as a strategic resource and tool. We need to put information to work as a tool to empower the public to protect, restore, and manage ecosystems.

Environmental information must be a prominent application of the NII. We must create within the NII an "environmental channel" to allow people to find, develop, and share the information they need for empowerment and to catalyze feedback loops, changing behavior to result in positive changes for the environment.

Much of the vision described has been technically demonstrated in other contexts, like the financial, weather, and sports realms. Also, the Environmental Resources Information Network in Australia, the Sustainable Development Information Network in Massachusetts, the Right-to-Know Network (RTK-Net), and other advanced practitioners already have demonstrated some of these capabilities in the environmental arena. In collaboration with the United States Fish and Wildlife Service, Turner Broadcasting has also created a multi-media "electronic field trip" that allows students to explore the wetlands environment of the Okefenokee Swamp.

Imagine the time in the not-very-distant future when virtually every home is connected to the information highway. It is a given that you will be able to "surf" through on-demand video entertainment and engage in interactive home shopping. It is also a given that you will have access to a tremendous range of financial, weather, and sports information. In the vision, you also have interactive access to a vast range of environmental information — in effect, an Environmental Channel connecting citizens like CB radio on the information highway.

The Environmental Channel will offer major capabilities. It will allow you to explore past, present, and predicted future environmental conditions at local, state, regional, national, and global scales, using ecosystem or political boundaries. It will provide "what-if?" modeling, visualization, and simulation capabilities for you to explore alternative future scenarios. The Environmental Channel will provide information about the natural resources in your area and the stresses upon those resources. It will provide solution-oriented, empowering information to help you identify what you can do to minimize harm and to improve the environment. It will allow you to "publish" your own observations about the environment, your ideas and your questions. You will be able to find information and other resources and collaborators for environmental efforts.

The idea is to draw inspiration from the weather information infrastructure, which provides rich information about weather phenomena we can only react to. The goal is to provide comparably rich information about the environment. Because we can manage many aspects of the environment, ubiquitous information will stimulate feedback mechanisms that affect individual and corporate behavior.

The best illustration of what is possible comes from the Toxic Release Inventory (TRI). TRI was mandated by the Emergency Planning and Community Right-to-Know Act, which was Title III of the Superfund Amendments and Reauthorization Act of 1986. Under TRI, manufacturing companies have been required to report on their estimated total releases of toxic chemicals into the environment. This information has been available to the public in many forms, including through on-line databases. When reporting began in 1988, such information had never been compiled. As the chief executives of some of the nation's largest chemical companies began to see the totals they were reporting, they were appalled. They announced voluntary initiatives to reduce their toxic releases, in some cases by 90% over 5 years. Here we see an example of the feedback model in action — an information program caused a modification of behavior, which resulted in beneficial changes for the environment.

It is feasible today to deliver text, graphics, image, animation, and video information about environmental conditions over the Internet. Consider the flashy information products you see in the realms of financial, weather, and sports information. The Environmental Resources Information Network in Australia provides one of the most compelling demonstrations of what now is also possible in the environmental realm. In the United States, Federal agencies, State and local governments, and private companies are building a clearinghouse for geographically referenced environmental, socioeconomic, and other data as part of the National Spatial Data

Infrastructure. The clearinghouse will allow producers to make their data available to a wider audience, and will allow users to find and obtain data of interest.

Imagine weather-type maps and images that provide current information about pollution conditions locally, regionally, nationally, or globally. Would it influence behavior if you could see that your local area typically has pollutant levels many times higher than another area? Would you want to know why? Imagine visual images that show past conditions and project future conditions based on current status and trends. Would it influence behavior if graphical predictions indicate that major pollution increases should be expected? That all but the last remnants of an ecosystem will be destroyed within the next few years?

Environmental Channel users should be able to define their areas of interest based on political, ecosystem, and other boundaries. They could then track past, present, and forecasted future pollution, ecological conditions, land-use/land-cover, and human and industrial demographics for those areas.

Visualization/Simulation

Imagine you have the capability to interactively run models to test alternative assumptions and scenarios and to simulate and visualize the outcomes. Suppose a large company is planning a massive development near where you live. You join a discussion hosted by your local PTA or civic association and help use simple tools to visualize the impact of the planned development on traffic, pollution, biodiversity, and other factors. Suppose that you can test the effects of different assumptions and different scenarios for the development. You aren't forced to rely on the word of "experts'" pronouncements. Would it change your behavior? Would it change corporate developers' behavior?
We are beginning to get comfortable with modeling tools through software like SimCity™ from Maxis Corporation. Popular both with children and adults, SimCity™ allows its users to design their own cities, complete with supporting finances and infrastructures, and to simulate the evolution of the cities over time. SimCity™ is easy to use, surprisingly realistic, and teaches much about the issues city planners and citizens face.

Easy-to-use modeling software can create "sim-ecosystems," allowing people to analyze or design ecosystems and simulate their evolution under different conditions, assumptions, and management practices. Using the Internet and the future NII, teams of interested people will collaborate to build these simulations, try them out, and seek consensus about desirable future outcomes.

Modeling and visualization tools will aid understanding of past, present, and predicted future environmental conditions at various geographic scales, using the types of tools that have been previewed by weather information specialists and the game simulators. These tools will also help us understand and visualize human impacts on the services provided by ecosystems — services such as water filtration, flood control, and temperature regulation.

Although it is difficult to assign hard-and-fast economic values to such ecosystem services, it should be easier to assign quantitative units and estimate impacts on service levels and inform the nation about the bottom-line accounting for service levels. TRI did something similar by establishing poundage of toxic pollutants released into the environment as a measuring stick. Similarly, changes in land-use and land-cover can be reported from local up to national levels, so that people can see the numbers for losses of forest, increases in pavement, and so forth.

The financial realm provides tremendous information about financial resources, their value, and speculative boosts and threats to their value, such as inflation. In a similar vein, detailed ecosystem indicators and indices should be readily available, so that people can track progress and changes in the environment. People could even define and track their own "portfolios" of ecosystems of interest, and see how they're faring over time.

You will be able to monitor the environmental assets of your areas of interest — for example, the species known to occur there and their estimated abundance. You will also be able to track the status of threats to your natural resources and progress toward sustainability.

Groups like the WorldWatch Institute have demonstrated a glimpse of what could be done. WorldWatch publishes the "State of the World" and "Vital Signs" annual reports, which provide data on resources and stressors and changes in indicators. In our vision, the Environmental Channel will allow users to interactively select indicators and monitor their status, with the kinds of simulation, modeling, and visualization capabilities previously mentioned.

The public seems hungry for solutions, for more useful information. The Environmental Channel will provide abundant information to empower people and help them find solutions to environmental concerns. What can we do about reducing trash in our neighborhood, controlling invasive plants choking our park, recycling, conserving energy and water, cutting pollution and reducing transportation costs? The same technologies that will be bringing us home shopping and entertainment can bring us environmental empowerment and interactive capabilities to respond to questions and find good answers.

The RTK Net has demonstrated that making a range of environmental information freely available to grassroots activists can empower them to work on behalf of the environment and human health by working with industry to find solutions and avoid litigation. And yet RTK Net has only been able to deliver a fraction of the information needed and that the Environmental Channel could deliver.

Taking a cue from today's Internet, we can envision the NII providing environmental frequently-asked-questions and answers, case studies, pointers and how-to guides to best environmental practices and help facilities. The entire corpus of public information products could be readily available. The Environmental Channel can be a mechanism that brings all of the local, State, and Federal environmental agencies together as a single, "virtual agency" that empowers the public with solution-oriented environmental information and capitalizes on the widespread public interest in and concern for the environment.

The Environmental Channel will not be some centralized digital broadcasting service with the public as passive consumers. Rather, the public will be encouraged to participate actively. When interested people make observations about the environment, they will be able to publish their information over the channel, sharing it with any of millions of people around the world. Vice President Gore's Global Learning and Observations to Benefit the Environment (GLOBE) initiative contemplates precisely such interactive involvement by students, who will gather environmental data, ship it out over the network, and receive back processed information that synthesizes their observations with those of others all over the world.

If you observe an interesting natural phenomenon, or if you have creative ideas about a problem, or if you have collected data you wish to share, the Environmental Channel will give you a means for sharing.

The Environmental Channel will help people with shared interests to discover each other and explore ways to collaborate. Because you will have the capability to publish your observations, ask your questions, and make your statements — and to explore and respond to the observations, questions, and statements of others — you will discover future collaborators, friends, colleagues. Geographic separation and differences in background will matter little compared to the spark of common interests and strong capabilities to communicate and examine ideas. Because it will be decentralized and an open market, ideas will compete on their merits rather than merely the publishing budgets of their main advocates. The Environmental Channel could be a force for equity and justice.

Thousands of volunteer efforts all over America are helping to restore local ecosystems. The Environmental Channel will empower people to express their interests in their local ecosystems by finding opportunities to work together on

volunteer projects and coordinate efforts to maximize collective results.

Further, the Channel will make it relatively easy to find and use empowering information resources to develop creative solutions and better approaches for sustainable development.

PART IV: How Are We Going to Get There?

Because the environment provides the foundation for a healthy economy and quality of life, and because we cannot "manage" ecosystems without information, we believe the Nation must build an environmental information infrastructure at least as prominent, exciting, compelling, and powerful as the infrastructures we've built for financial, weather, and sports information. We can take the best innovations from those other fields, seek to do better yet, and strive for major economies of scale as the NII is built by the private sector.

But the government must provide enough steering to ensure that the environment isn't shunted aside in the pursuit of expected greater short-term profits in other arenas. For in the long run, nothing can be more profitable than an NII that enables us to hand over a better environment and a sustainable, healthy economy to our children.

To empower the public with environmental information, the Federal Government must facilitate and focus the vast network of stakeholders to bring quality, useful and understandable information to the people. It will be crucial to involve many groups such as colleges, universities, non governmental organizations, and government agencies to inventory and publicize their environmental information holdings. These valuable information resources need to be available in readable and understandable formats. The NII needs to be built to ensure that the public at large can reach the vast holdings of information. It will be necessary for the government to make a solid commitment to have its information available and promoting its dissemination.

Working with programs such as GLOBE (Global Learning and Observations to Benefit the Environment) and the President's Council on Sustainable Development are important to ensure a broad array of contacts in the widespread use of the application. Other federal efforts should be coordinated and incorporated into the environmental information channel such as the Government Information Locator Service, the National Spatial Data Infrastructure activities and other major projects that involve the schools, libraries, and government service centers.

A dynamic interactive, on-line ecosystem discussion facility should be available to the public. It would be an outlet for information on ecosystems protection methods from the Izaak Walton Society, as well as, recycling tips from industry. This on-line service would be a place for questions and answers. Communities would be able to access and provide feedback on the information that empowers them to take action. They would be able to interact with the experts to explore their problems and concerns.

Issues and Questions to be Addressed

Information Quality and Standards

Poor quality data and misinformation could cause more harm and confusion rather than understanding and appropriate action that protects the environment.

- How can the Federal Government facilitate the quality of the data and information that might be piped through the environmental channel?
- How can federal agencies prepare and present the vast amounts of environmental data so that it can be readily consumed and digested by the public and stakeholders?
- How can the Federal Government promote the voluntary acceptance and use of data standards by the various interests who will generate environmental information for public consumption?

Widespread Involvement

- How should the Federal Government encourage and facilitate the varied interest groups and stakeholders to make high quality and readily understandable information available to the general public at large?

- Should the Federal Government expand the incentive grants program for the thousands of U.S. non governmental organizations active in environmental information dissemination in order to facilitate their participation in the Internet and catalyze the sharing of information among NGO's?

- Should the Federal Government sponsor community-based demonstration projects of public empowerment with environmental information such as the Sustainable Development Information Network in Cambridge, Massachusetts?

Partnerships

- What is the role that the Federal Government should take in ensuring that quality information is populated and disseminated on the environmental information channel?

- How can the Federal Government best promote the goals of the NII and its application to empower the public with environmental information capitalizing on the expertise of environmental and economic groups who have considerable interests in having public support?

- Should the Federal Geographic Data Committee, in concert with the President's Council on Sustainable Development, establish a formal liaison with the Sustainable Development community to identify data requirements and catalyze linkages to local, state, and regional councils and governments?

Training and Education

- How should the Federal Government target efforts provide assistance to communities and interest groups to take full advantage of the NII application of public empowerment with environmental information?

- What efforts does the Federal Government need to take to assist the public in understanding and using environmental information?

- Should the Federal Government create simple instructional materials for electronic empowerment using the Internet, and publicize such information through media such as national television and magazines?

Arts, Humanities, and Culture on the NII

DRAFT FOR PUBLIC COMMENT

"While no government can call a great artist or scholar into existence, it is necessary and appropriate for the Federal Government to help create and sustain not only a climate encouraging freedom of thought, imagination and inquiry but also the material conditions facilitating the release of this creative talent. The world leadership which has come to the United States cannot rest solely upon superior power, wealth, and technology, but must be solidly founded upon worldwide respect and admiration for the Nation's high qualities as a leader in the realm of ideas and of the spirit."

— National Foundation on the Arts and the Humanities Act of 1965

"We see the arts not as an amenity, not as a luxury, but as a necessity in building America's communities."

— Henry Cisneros, Secretary of Housing and Urban Development

Introduction

This paper is based on a number of assumptions or principles, and it may be useful to state them at the outset. First and foremost, we assume that it is a social good, to be encouraged by our government, that the United States have an educated populace, with equal access to information.

We take it as a given that the humanities and the arts will provide a crucial part of the content of the expanded NII, and that the NII will reach children with new learning tools and forms of entertainment. We are convinced that the arts and the humanities will be at the forefront of developing both. Because humanists and artists are experts at using symbols, managing data, and making the presentation of data and complex ideas "user friendly," engaging, interactive, and even fun, they should be involved from the outset in efforts to design an expanded NII.

The for-profit entertainment and publishing sectors, as well as the huge U.S. copyright industry, draw upon and use the work of individuals and cultural institutions. Consequently, we assert that investment in the latter is a form of research and development for a very profitable American industry. We also recognize that the nonprofit cultural organizations lack adequate resources to embrace and advance new technologies without further public and private investment.

Also it is important to note that the arts and the humanities are international in scope. Just as the Internet now links computers worldwide, so will the NII facilitate international dialogue, cultural exchanges, and cultural commerce.

PART I: What Is the Application Arena?

Humanities and Arts Institutions, Museums and the National Information Infrastructure

Standing at the threshold of an information revolution we can see, with a momentary keenness of vision, that an improved NII can unite us as a people as it educates and enlightens us as individuals. We can use it to give all citizens, wherever they live, whatever their means, access to the building blocks of knowledge and allow them to read, research, learn, combine and create understanding in original ways. We can present the richness of our diverse cultures to promote understanding; we can communicate across cultures and economic strata. Or we can divide into subcultures composed of the elite and the unschooled, the technology haves and have-nots.

The promise and the vision of the NII is that all Americans will have access to a wealth of information in any number of arenas, from health care to history, from poetry to physics. In the next century the NII will be the means by which most Americans receive their information, and the data, the imagery and the sounds it conveys will shape their very ideas of what culture is and influence their concepts of, and participation in, our democracy.

The humanities and arts in all their variety and historical context comprise what we experience and think of as "culture."[1] Culture is concerned with what is known and valued. Culture continually renews and reshapes itself, yet culture is a continuity. It is the domain of the people as well as of the artists and the scholars. It is the fiction of Toni Morrison as well as the African-American oral tradition. It is ragtime and rhythm and blues, Gershwin and Copland. It is constitutional history and the history of our towns and cities and immigrants, as told by our citizens. It is the collection of world cultures that form and inform us. It is how we understand ourselves, our society and our democracy, and our relationship to the world. It is how we use knowledge, symbols, and sound to communicate.

Most Americans recognize that the deepest substance of communication is the province of the arts and the humanities; our dreams, passions, and struggles as a nation are often reflected and identified first in this realm. We recognize that our artists and scholars are our most eloquent communicators. However, what we are only beginning to acknowledge is the economic contribution of the cultural sector to our economy. As one important private foundation notes, "Our literature, our performing arts, the holdings of our museums, archives and libraries, and, above all, the creative energies of our people will provide the educational and cultural content of the NII."[2]

The visual display of information, the understanding of the impact of design on environment, the ability to analyze and parse vast quantities of information and present them in a comprehensible manner all require the discipline and skills of the arts and the humanities. It is the innovators in the artistic and scholarly community whose ability to manipulate and master the latest media, special effects, enhanced sound and visual quality and new production techniques that has put and will keep our nation on the cutting edge of emerging technologies. More than just consuming new technologies, the humanities, the arts, and the industries related to them drive technology by generating ideas, by supplying content for the information highway, and by serving as an important testing ground for new ideas — leading

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[1] In this paper (as in the authorizing legislation for the National Endowment for the Arts) the arts include music, dance, drama, folk art, creative writing, architecture and design, painting and sculpture, photography, graphic and craft arts, costume and fashion design, motion pictures, radio and television, and film, video and sound rerecording.

The definition of the humanities encompasses languages, both classical and modern, linguistics, literature, history, jurisprudence, philosophy, comparative religion, ethics, the history, theory and criticism of the arts, and archaeology and other fields in the social sciences that employ humanistic methods of inquiry.

[2] *The National Information Infrastructure*, the J. Paul Getty Trust, May 12, 1994.

to more breakthroughs and drawing critical investment capital into projects.[3]

The humanities and arts generate intellectual property, a crucial component of the entertainment, information and core copyright industries. Collectively, these industries constitute a dynamic sector of the economy responsible for the creation of new jobs and export earnings. The International Intellectual Property Alliance reports that "core copyright industries" (including publishing and software) in 1992 accounted for $206 billion in value added to the U.S. economy (about 3.6 percent of GNP). At least 40-46 percent of this figure could be attributed to records, tapes, CDs, motion pictures, TV, video, newspapers, books, and periodicals.[4] The copyright industries employ more than 5.5 million workers in the United States. And these industries are growing more quickly than the economy as a whole: between 1987-1991, the industries grew at an annual rate of 4.2 percent compared to 1.5 percent for the economy overall.[5] The IIPA estimates that 1992 foreign sales by copyright industries totaled $39.5 billion.

The challenge of the NII is to nourish the growth of intellectual property and seed its development in many forms.[6] We must recognize the contribution of the cultural sector in entertainment and in spiritual sustenance but also in terms of productivity and contribution to the GNP. The humanities and arts are well-positioned to contribute to the digital communications revolution. Increasingly, the nonprofit cultural sector functions as the "research and development" arm for the for-profit industry.

The role of the federal government is limited but crucial: national policies must provide incentives for the artistic and intellectual creativity and research essential to the development of content for the NII.

In addition to their role in the copyright industries, the arts and the humanities nurture creativity in all walks of life and provide a number of benefits that cannot be quantified precisely. The NII will help all Americans attain greater access to the tremendous variety of cultural resources available throughout the nation; by helping to harness these resources, an enhanced NII will offer all Americans opportunities to pursue life-long educational and cultural interests.

Already, Americans are spending increasing amounts of their leisure time — and their incomes — attending lectures, symphony concerts, operas, dance, plays, and visiting art galleries and museums; reading fiction, poetry, and non-fiction works and viewing high-quality programming on television. Consider the following:

- In a study published in 1994 by the National Assembly of Local Arts Agencies, the direct expenditures of nonprofit arts organizations are estimated at $36.8 billion. The number of jobs supported by this sector alone is 1.3 million, not including self-employed artists.[7] Moreover, the arts, entertainment and intellectual property industries make substantial and vital contributions to key regional economies and to urban economic development.

- Of the major sectors of the California economy, the motion picture industry showed the largest employment growth rate: while manufacturing employment from 1990-1992

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[3]The Public Affairs Coalition of the Alliance of Motion Picture and Television Producers, *The Economic Impact of Motion Picture, Television & Commercial Production in California.* (Los Angeles, 1994) p. 6. (Executive summary on technological development).

[4]International Intellectual Property Alliance. *Copyright Industries in the U.S. Economy:* 1993 Perspective. (Washington, D.C., 1993), Table 10.

[5]International Intellectual Property Alliance. *Copyright Industries in the U.S. Economy:* 1993 Perspective. (Washington, D.C., 1993), p. 9.

[6]We recognize that copyright issues are a crucial aspect of the NII's development. Many believe that our body of copyright law is flexible enough and our technology powerful enough (with encryption and software enveloping) to protect our creative communities. This entire area of the law is currently under review, and copyright issues are examined in a recent report by the IITF working group on intellectual property rights.

[7]National Assembly of Local Arts Agencies. *Arts in the Local Economy* (Washington, D.C., 1994).

declined more than 15 percent, motion picture employment increased by more than 5 percent.[8]

- In Denver, Colorado, a study commissioned by the Colorado Business Committee for the Arts found that the economic impact of non-profit cultural organizations in the Denver metropolitan area included a payroll of $161 million and more than 11,000 jobs. The study also noted that more people attended cultural programs than professional sports events.[9]

- The Port Authority of New York and New Jersey reports the total economic impact of arts institutions (including nonprofit institutions, commercial theaters, television and film, museums, galleries, and auction houses and their visitor service businesses) on the NY-NJ metropolitan region to be $9.8 billion. Adjusted for inflation the arts grew by 14 percent in the last decade. Nonprofit institutions added $2.7 billion to the economy directly.[10]

- Museums, in particular, attract more than half a billion visits each year — the equivalent of two visits per American per year, and their programs attract almost 700 million participants annually, according to a survey undertaken by the American Association of Museums. The effects of these visits go far beyond the museum; the ancillary spending which occurs when museum visitors spend money on taxis, restaurants, or hotels, makes a significant contribution to the health of the surrounding community.

- A 1994 study of the impact of the Smithsonian Institution on the economy of the greater Washington, DC area found that during the previous year this complex of museums and research facilities generated a total of $6.7 billion in economic activity, 91 percent of which derived from out-of-town visitors.[11] To provide a frame of reference, the collective operating budgets of all American museums totals only $4 billion.

- Although it is more difficult to estimate figures for the humanities in higher education, it is worth noting that universities and other educational institutions have a significant economic impact. Data compiled by Independent Sector indicate that nonprofit educational institutions are the second-largest employer in the nonprofit sector. In 1990 educational and research organizations employed 1.86 million Americans, second only to the health care sector. Nonprofit education contributed over $35.7 billion dollars in salaries to the U.S. economy in 1990.[12]

- The humanities and arts are increasingly important to the American people. According to the Bureau of Economic Analysis, consumer spending on the performing arts, as a percentage of after-tax income, rose from .07 percent in 1970 to .12 percent in 1990. During this same period, spectator sports decreased from .16 percent to .11 percent.[13]

- In the decade from 1982 to 1992, increasing numbers of Americans participated in the humanities and arts through attendance at live events, through broadcast and recorded media, and through personal performance and creation. In 1992, 41 percent of adults in the United States attended a performance or

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[8]The Public Affairs Coalition of the Alliance of Motion Pictures and Television Producers, *The Economic Impact of Motion Picture, Television & Commercial Production in California*, 1994.

[9]Cited in *Jobs, the Arts, and the Economy: Highlighting the Findings of from NALAA's "Arts in the Local Economy" Study* (Washington, D.C., NALAA, 1994) p. 13.

[10]Port Authority of New York and New Jersey. *The Arts as an Industry: Their Economic Importance to the New York-New Jersey Metropolitan Region.* (New York: 1993).

[11]Greater Washington Research Center. *The Economic Impact of the Smithsonian Institution on the Washington Metropolitan Area.* (Washington, DC, 1994).

[12]*Nonprofit Almanac*, 1992-1993. (Washington, DC: Independent Sector, 1993), p. 126.

[13]U.S. Department of Commerce, *National Income and Product Accounts of the United States*, statistical tables, various years.

exhibition during the previous year, in contrast to 39 percent in 1982 and 1985. Audiences for opera, classical music, and jazz programming on radio increased by 49, 60, and 71 percent, respectively. The attendance rate at museums and galleries in 1992 was up almost 5 percent from 10 years before; total attendees approached 600 million in that year.[14]

- In the past 30 years, the number of non-profit cultural organizations in the United States has virtually exploded.[15] Of the 8,179 museums in the United States today, two thirds have been created in the last 30 years. Since 1965, the number of professional, non profit theaters has grown from 56 to a network of over 400 today. Similarly, the number of professional dance companies increased from 37 in 1965 to 250; and the number of professional opera companies increased from 27 in 1965 to over 100. During this same period, the number of professional symphony orchestras has more than doubled (from 110 in 1965 to over 230); and the number of small press book publishers has increased by nearly 500 percent (from 650 to nearly 3800)! In the 20 years between 1970 and 1990, the number of artists in the American population (those employed full or part time in an artistic endeavor) more than doubled from approximately 737 thousand to nearly 1.7 million.

Unfortunately, the economy of nonprofit cultural organizations is often misunderstood. Despite their evident popularity many performing arts groups and nonprofits require subsidies to offset operating deficits, just as tuition costs never fully capture the true cost of operating a liberal arts college or private university.

For many organizations, a small but often crucial part of that subsidy comes from the Federal Government. But in recent years the National Endowment for the Humanities and the Institute of Museum Services appropriations have remained flat, while the National Endowment for the Arts has been cut by 2.5 percent. The two Endowments have lost close to 50 percent of their purchasing power in the last decade. Federal and state budget cuts have been passed on to the field. In addition, private funding trends are down. The percentage of foundation and corporate giving to the cultural sector has decreased from 14 percent in 1991 to 12.7 percent in 1992. Many businesses report that they will either hold cultural spending at current levels or consider reducing it.

The primary place of the arts and humanities in education is being recognized at the local level and nationally in the recent Goals 2000 legislation. Training in the many disciplines is a base part of what it means to be truly educated and to appreciate the richness of thought and culture. The arts and humanities are also effective at teaching communication, teamwork, making discriminating choices, instilling self-discipline and improving constructive self-expression. Teachers are learning how to use the humanities and arts to present other subjects and to take a cross-disciplinary approach. They also use them to enliven material and to give children activities that help keep them in school. More research is showing how effective these disciplines are at reaching the various senses and "intelligences" that make up each child. Research also shows that training in the arts improves performance in other subjects.

New technologies are becoming effective teaching tools. They not only convey information about the arts and humanities, they invite children directly to participate in creative and scholarly activities. We endorse the concepts put forward in the paper: *A Transformation of Learning - Use of the NII for Education and Life Long Learning*, published in the first volume of *Putting the Information Infrastructure to Work*.

Users of a National Information Infrastructure — especially artists and scholars — will have the opportunity to be both information consumers and information providers. In the interactive

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[14]National Endowment of the Arts, *Arts Participation in America: 1982-92*. Prepared by Jack Faucett Associates; Compiled by John P. Robinson, University of Maryland. October, 1993.

[15]National Endowment of the Arts, *Arts in America 1990*:, Appendix C.

environment of the NII, the opportunity for information traffic to move two ways will permit the creation of unique works and the augmentation of existing works. It will no longer matter where in the country a person is located, nor will it matter where the desired information resides. The NII could permit any one person or group of persons to have access to a large body of materials or ideas, and to study them, combine them in new ways, and make their results available to anyone else.

Cultural Heritage in the Virtual Museum

A young Native American living in a remote pueblo in New Mexico wants to explore his heritage. Having access to the elders of the community, he is fortunate to have heard the stories and to have developed some sense of belonging. But, over the years, tribal and religious artifacts that help to define him as a tribal member have been removed to be placed in museums and collections all over the country. He is unable to travel to see, understand and appreciate the relics of his past, but he is able to go to the tribal center where he may browse through a virtual museum — a museum without walls, a museum that travels to him. Because the images are digitized representations of the artifacts, he is able to expand and rotate the images to view detail. He listens to a guide's explanation of the collection, as well as comments on each piece by Native American experts. He is traveling with the help of his virtual guide, and can explore the dusty corners of this virtual museum on his own. He comes away from this experience with a greater sense of his community and his own identity, a sense that his heritage has not been lost or stolen, an understanding that these precious relics may be viewed and appreciated by anyone, not just those with sufficient money to visit the museum in person.

Learning Music with Brahms

A young person in a rural school is curious about music, and wants to learn more about great composers. Through an interactive, multi-media system she accesses a choral work by Brahms which she can hear through the high-quality headphones she is wearing. As the selection begins to play, her video monitor displays the image of the original hand-written score, penned by the master himself. To her surprise and delight, she sees whole sections of the manuscript scratched through in red pen, with comments from Brahms's former teacher criticizing his efforts and suggesting ways to improve the piece. She realizes that everyone has teachers, that instruction and practice improve people. She now has a new outlook on education and music. Even more, she hears and sees how the work uses a standard musical form in surprisingly new ways. She can start and stop the piece, can hear and see the various orchestral parts played separately, and can read explanatory notes about the work and the composer.

Dancing in Real Time

A dance choreographer in a large Eastern city — perhaps someone of the stature of Merce Cunningham — is asked to develop a new work for a dance company in the Midwest. He creates the new work using a special program on his computer called Lifeforms. As the new work evolves, he uses the NII to transmit his choreographic ideas and movements to the composer who lives in the American Southwest and who is writing the original music which will accompany the piece. The following morning, using the NII, she forwards to the choreographer portions of her composition reproduced and digitally recorded using a synthesizer. Later that week, in a two-way audio and video exchange, the choreographer and the composer collaborate to bring the musical composition into final form. The following week, the choreographer transfers to the artistic director of the dance company the Lifeforms program with his choreography, as well as the completed score for the music. The company begins its eight-week rehearsal of the new work. During the rehearsals, the choreographer observes the realization of the dance piece as it progresses. Using video teleconferencing over the NII, he is able to interact with the dancers and instruct them in the movements, and the dancers are able to ask questions and to make suggestions for possible revision of the piece. The work is ultimately performed before a local audience, and watched live throughout the region in high-definition video.

Later, the work is made available through an archive of video recordings of dance works, accessible through the NII.

From Site to Byte

Paleontologists are digging in an archeological site expecting to find remains of prehistoric mammals. They uncover objects they do not expect to find: apparently manmade utensils made of an unidentified metal which begins to deteriorate as soon as it is exposed to the air. They do not have anthropologists on their team, nor any other expert who is able to make a tentative identification. Through the NII, they are able to contact ethnographic conservators at a natural history museum to receive instructions on how to safeguard the objects from further deterioration. The team is subsequently able to draw on research materials from the linked archives to determine the provenance of the objects. The museums are linked with other educational institutions (libraries, universities, and schools) to share the research and information about these artifacts.

What is the Public Interest in Promoting the Application?

American artistic creativity is envied throughout the world; America's universities, libraries and museums are among the world's finest. The arts and humanities are a crucial ingredient in the American education system. Today, as part of the administration's Goals 2000 initiative, the arts enjoy enhanced Federal recognition as core K-12 subjects — along with English, history, civics, geography, mathematics, science, and foreign languages. In the spring of 1994 Secretary of Education Richard Riley issued a comprehensive set of standards for K-12 education in dance, music, the visual arts, and theater. National standards for history and civics are almost complete, and parallel efforts in English and foreign languages are underway.

The humanities and arts can play a vital role in solving some of America's most pressing social challenges. They can help to bring hope to America's at-risk youth. With the NII our cultural institutions can reach beyond their walls to touch the lives of the poor, the old, or the otherwise disadvantaged. If used with care and imagination, the new technologies can enable the arts and humanities to create understanding between races and help build bridges among different cultures.

How can the NII Help?

Education in the arts and humanities will be vastly augmented and expanded through the facilities of the NII. For example, literacy in the arts is something that every child has a right to expect during the course of his or her education. No education in the arts, however, can proceed without exposure to the art form itself. With the inclusion of the arts in the basic curriculum, there will be increased demand for art teachers and teaching materials. Today, hard-pressed school systems are complaining of a shortage of teachers and resources. The NII has the potential to help schools overcome these handicaps in time to meet the higher standards demanded of American schools.

But the benefits of the NII will not be limited to the schools. The American public already has a keen interest in obtaining access to quality arts and humanities programming. National Public Radio stations across the country claim an estimated 15 million listeners each week. PBS' broadcast of *The Civil War* attracted a record viewership for one program of some 13 million viewers. Television viewers, in particular, continue to demonstrate a desire to exercise choices for themselves and for their children in selecting programs with cultural content, presented at times of their choosing. Unfortunately, cable television, which now reaches over 60 percent of U. S. homes, has not always demonstrated an ability, or a willingness, to deliver on one of its original promises: to provide its subscribers an opportunity to choose from a variety of quality programs and series. Many scholars, artists and advocacy groups are especially concerned that a National Information Infrastructure, if dominated by commercial interests, might offer little more than "500 channels of movies, games and shopping." An improved NII can bring into American homes and schools access not only to high-quality programming, but exploratory visits to museums,

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concert halls, art galleries, centers for folklore and heritage, and other centers of the arts and culture.

What is the Evidence of the Benefits?

The arts and humanities already constitute an important and growing sector of the American economy and increasingly serve a "R&D" function for the for-profit communications and entertainment industry. In addition to the considerable number of jobs and expenditures that nonprofit institutions currently provide, there is evidence that publicly funded projects in this sector serve as a testing ground for new ideas that often have commercial applications.

Here is one example that has important implications for the development of the NII: the American Film Institute, a nonprofit center that promotes study of film as an art form and provides training programs for young filmmakers and others interested in the industry, has taught digital film technology to over 5500 participants in one of its training programs. The AFI receives its primary support from the National Endowment for the Arts and supplemental support from the NEH. Countless other examples could be cited: over the years NEA fellowships and grants have enabled many of the best American playwrights to develop their work. Such commercially successful films as *Driving Miss Daisy*, *The Great White Hope*, and *Children of a Lesser God* began as plays supported by NEA grants. More recently, the acclaimed Broadway hit *Angels in America* was first produced by a nonprofit theater which received support from the Endowment for the Arts and the Fund for New American Plays, a joint venture of the Kennedy Center and the President's Committee on the Arts and the Humanities. Awards from the NEA's Design Arts program often lead to commercial applications. In the humanities, the success of the NEH funded series *The Civil War* by filmmaker Ken Burns created a lucrative secondary market for home videocassette and books based on the televised series. The impact of this nonprofit "R&D" deserves more study.

Cultural Dialog can be encouraged: On-line discussions among and between artists, scholars and people that encourage uncensored communications and cross-cultural understanding.

Most cultural organizations in the humanities, arts and museum worlds operate on small budgets with few staff. They struggle with the same needs: to keep the door open, receive new information, reach their audiences, and find new funding. They can greatly benefit from communicating with each other and their potential audiences or "consumers" on the NII. For example they could hear about new grants from private foundations and public agencies; they could share successful promotion ideas; they could publish touring schedules and save money through block booking performances and exhibitions.

- Example: The Benton Foundation Conference, "Shaping the National Information Infrastructure: the Public Interest Summit," featuring Vice President Gore attracted 650 leaders from non-profit organizations all over America. Policy discussions on public access, benefits to communities and on content were made available online, so that many more nonprofits could learn from the conference.

The humanities and arts nourish the civic spirit vital to a democracy. Critical thinking, an appreciation of America's past, and a willingness to work together for the common good are values developed by the arts and the humanities. The arts and humanities make important contributions to the on-going national dialogue that is essential to a democracy. To the extent that the NII creates a new public forum, it is essential that we provide opportunities for the public to have access to the best thinking and creative expressions available.

Electronic technology can enhance a citizen's involvement in the nation's civic culture through participatory, electronic forums that bring together scholars and members of the public. The new technology can also foster the dissemination of cultural knowledge to the public.

- Example: The Impact of the Electronic Village on the Quality of Life. An NEH grant to Virginia Polytechnic Institute (VPI) in Blacksburg, VA, enabled VPI to sponsor "Choices and Challenges: The Quality of Life," a series of forums using scholars and community leaders to explore medical ethics and the impact of the "electronic village" on

the quality of life. This demonstration project involved, among other formats, a series of video teleconferences broadcast nationally by the Public Broadcasting Service. The first forum, "The Quality of Life at the End of Life," attracted an on-site audience of more than 500 and was downlinked to 133 sites in 34 states (to colleges, hospitals, air force bases, universities, and television stations) using teleconferencing provided by the PBS Adult Learning Satellite Service.

Arts and humanities build stronger communities. Our nation needs the positive influence of the arts and humanities to help forge a common identity, to communicate across the lines of division that unfortunately threaten to separate us into isolated racial, ethnic or regional groups. An accessible NII will be an essential tool in finding ways for the arts and humanities to touch unserved communities with new levels of imagination and resources. Already the arts and humanities are providing innovative solutions to the problem of at-risk youth, the problem of juvenile crime, and the problems of illiteracy and poverty.

- Example: Computer Mentors. In the summer of 1993 the Community Arts Training Program sponsored a multi-disciplinary Computer Graphics Program for 300 New Orleans inner-city youths. Originally designed as a vehicle to teach job training as well as basic skills, the program is unique in the way it exposes students to careers in the arts and the connection between high school and careers. In order to teach job skills (computer design, layout, desktop publishing) students were involved in the production of a magazine from start to finish. The resulting publication not only illustrated the connection between education and future employment, but also gave voice to the students' own experience and dreams.

PART II: Where Are We Now?

The current picture of computing in the humanities and arts is drawn from many sources. The projects listed below show great vitality, yet this picture of cultural computing represents a cacophony of projects with little reference to each other. As yet their development is guided by no systematic, coordinated policy. They exemplify often original and even heroic individual achievement, but cannot hope to represent the fullness of our cultural heritage and creations.

Few of the projects cited below have made provision for the archiving of their data. The reasons for such little viability, despite considerable vitality, are many. Most have to do with lack of support in one way or another, and by extension lack of coordination and distribution structures. The computerization of cultural projects and materials, viability and preservation, accessibility, the use of standards, plans for long term maintenance and distribution of cultural materials have not been seen until recently as candidates for major funding.

Selected Private Activities

The Software Industry

Microsoft has recently issued a CD-Rom guide to the National Gallery of Art in London and plans to develop a "virtual museum" for consumers. The Voyager Company has created a nonprofit venture, Voyager 501C3, to develop educational software. To date, this firm has produced educational software in American history, classical music and dance, and philosophy. In addition, Voyager is also preparing children's titles which will be interactive books and not mere games.

Individual Artists

One of the most vital areas of product development on the Internet are arts and culture applications. A survey of new World-Wide Web servers (which make text, audio, and video accessible online) reveals the health and enterprise of the cultural sector. A recent period showed a sample variety of the action on "the Web": Jazz Online, The Batish Institute of Indian Music and Fine Arts, Roy Lichtenstein Pre-POP 1948-1960 exhibit, The ALF MIDI(Musical Instrument Digital Interface), Shot of Rhythm Archives, The Electronic Journal of Analytic Philosophy, Pixel Pushers Exhibition of Original

Art, The Lynx literary magazine, Reba McIntyre, the UK DANCE all appeared on the net.

Artist Agencies

Among the first commercial companies to recognize the role of arts and culture in the content and information management arena are the "super-agencies." These agencies have already positioned themselves to translate the needs of the content providers they represent to the "rate companies" that are vying for product. They are forging the relationships between artists and the new media markets offered by the studios, utilities, phone companies, cable companies, and software companies.

Selected Public Activities

National Endowment for the Humanities

Since 1965 the federal government has spent a total of approximately $2.84 billion dollars in support of the humanities. This expenditure has generated over $2.1 billion in non federal support. The nation's expenditures for education at all levels comprised 7.5 percent of the Gross Domestic Product for 1991, or $425.2 billion.[16] The humanities comprise approximately 20 percent of the educational system and accounted for $85 billion of the GDP in 1991.

Educational institutions have a high impact on local and regional economies. In 1993 a study of the economic impact of spending by George Washington University on the greater Washington, D.C. economy found its payroll and purchases generated $1.2 billion in economic activity. This one university conducted business with 14123 local companies. That same year, the study found, the area's 25 higher education institutions had a total impact on the local economy of $17.25 billion.[17]

During 1993 the federal government through the NEH provided support for the humanities to 2197 institutions and individuals, including 35 elementary and secondary schools, 15 two-year colleges, 126 four-year colleges, 534 universities, 32 public television and radio stations, 206 libraries, museums, and historical organizations, 964 individuals, and 256 community organizations and other humanities institutions. During 1993, public humanities television programming reached a collective audience of 244 million viewers.

The National Endowment for the Humanities has been a leader in the development of computer applications in education and scholarly research, and especially in the creation of library information networks. Since 1980 all NEH grants for cataloging and processing primary and secondary resources in the humanities mandate that machine-readable bibliographic records be made available via one of three national, electronic networks supported by the Research LibrariesGroup (RLG), the Online Computer Library Center (OCLC), and the Washington Library Network (WLN). These nonprofit organizations collectively provide academic researchers and members of the public with electronic access to millions of books, serials, documents, photographs, sound recordings, oral histories, films, and videos held by the nation's public and research libraries, archives, museums, historical organizations through more than 20000 computer terminals at research and public institutions across the nation. Almost all the catalogs of the nation's largest research libraries are available for searching through the Internet.

National and International Communications Standards and Protocols

The Endowment is especially interested in projects to develop standards for the organization and verification of information transmitted in a networked environment.

Electronic communication in the humanities depends upon the use of common technical standards as well as protocols for formatting the context of electronic documents so that they can be read on many computer platforms and for transmitting and reading electronic information

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[16] *Digest of Education Statistics*, U.S. Department of Education, 1992.

[17] *Washington Post*, March 11, 1994, and Greater Washington Research Center.

using common descriptive terminology about where resources are located.

- International Standards for Text Encoding: The NEH has made awards to support the Text Encoding Initiative (TEI), which has drafted an international standard scheme using the Standard Generalized Markup Language (SGML) to encode humanities texts so that a user can navigate through an electronic document in the same way he or she uses a printed text. Use of the TEI standard will ensure the interoperability of electronic documents in the humanities.

- National Standards for Networked Information: The NEH has supported the work of two national standards groups, the Committee on the Interchange of Museum Information (CIMI) and the Art Information Task Force (AITF), a collaborative venture organized by the College Art Association and co-sponsored by the Getty Art History Information Program and the NEH. For instance, in a project with important implications for museums and universities alike, the AITF has successfully established a definitive set of categories for the description of works of arts, including both three-dimensional objects and prints and graphics. As the digital storage of visual materials becomes ever more commonplace, these standards will enable a user to locate desired images efficiently, wherever they may be stored on the network. The CIMI effort focuses upon the development of a communications exchange format for conveying information electronically among institutions and researchers.

Internet Access to Humanities Resources

To ensure the broadest possible electronic access to information in the humanities, digitized text images, and related information must become directly accessible on the Internet. Examples of NEH-funded projects include:

- The Dead Sea Scrolls Project: Digitization can be used to enhance photographs to clarify hidden information that would otherwise be lost to scholars. In 1994 the Endowment awarded a pilot grant to the Ancient Biblical Manuscript Center to develop procedures for digitizing and making available over the Internet images of the Dead Sea Scrolls, in addition to the distribution of scroll images via CD-ROM. Scholarly users will be able to enhance the digital images to reveal characters that are not plainly legible in the original documents.

- Denver Public Library Digitized Photographs Project: In 1993 the Denver Public Library received an NEH grant to digitize 30,000 photographs in its Western History Collection. The photographs and bibliographic citations will be made available to researchers worldwide through the Internet.

- The Making of America Project: An inter-institutional, cooperative project to digitize 100000 humanities monographs for Internet access is underway, guided by librarians and scholars at Cornell University. Volumes in "The Making of America: 1860-1960" will encompass a single theme, the development of the infrastructure of America — transportation, communication, and the built environment.

Digital Technology and the Preservation of Cultural Resources

The new technology offers the possibility of capturing and saving knowledge for future generations in a format that can be transmitted via the Internet to researchers throughout the world.

- Project Open Book: At Yale University, with support from the NEH, 3000 volumes on microfilm will be converted into digital form to test assumptions about relationships between scanner settings, microfilm quality, and document quality; to refine workflow configuration in order to optimize productivity; and to measure and record cost and time data. In addition, newly-developed document management software will allow editing that

will provide electronic links between a bibliographic record and parts of a document (e.g., table of contents, chapter, page). User access will be made possible on a limited scale and evaluated in preparation for a later phase that will provide full network distribution, both to Yale and to the Internet community.

- The Cornell/Xerox Project: Utilizing specialized software and hardware contributed by the Xerox Corporation, Cornell University will test a prototype system for recording brittle books as digital images and producing, on demand, high quality paper documents. In addition, a preservation microfilm will be produced from the digitized volume. An advisory committee, composed of university faculty, library subject specialists, and preservation staff will select 10000 volumes from the university's humanities collections for conversion to digital images at 600 dpi (dots per inch). A technical committee will evaluate the quality of the images, the efficiency of the production system, and the comparative costs of using a digital intermediary to produce preservation microfilm.

Humanities, Technology, and the Schools

The teaching potential of the new technologies has been dramatically demonstrated with the development of hypermedia programs which allow students to explore a subject through interactive manipulation of textual, audio and video information in a variety of non-linear formats. The expansion of CD-ROM technologies and the release of data collections in digitized formats has made the hypermedia format widely accessible and retrievable via such electronic networks as the Internet.

- Hypertext in the Classroom: The Massachusetts Institute of Technology has received support for the development of hypermedia teaching programs in Spanish, Japanese, and French, while another major Spanish language hypermedia project has been funded at the University of Michigan. Foreign language instruction is not the only venue in which these hypermedia programs may offer contributions, and the M.I.T. team has also received support for the development of a hypermedia interactive Shakespeare classroom presentation system.

- Teaching and Telecommunications: Telecommunications have been used to make courses accessible to geographically dispersed students and to such population groups as working parents who make up an increasingly significant segment of the U.S. undergraduate population. NEH has supported projects at Ohio State University, for video-based telephone instruction for secondary teachers of Russian; at the University of North Texas, for the incorporation of video-based interviews conducted in Normandy into technology-based instructional materials; and at Pennsylvania State University, for telecommunicated instructional materials in archaeology.

National Endowment for the Arts

The Arts Infrastructure

Since 1965, the Federal Government has provided American artists, arts institutions and arts organizations over $2.9 billion in funds. State appropriations for the arts in roughly the same period total nearly $3.7 billion. In each of the fifty states and the six "special jurisdictions" (the District of Columbia, Puerto Rico, the Virgin Islands, American Samoa, Guam and the Northern Marianas), state arts agencies or their equivalents provide leadership and guidance, and administer grant programs similar to those at the Federal level. Six regional organizations likewise provide funds for regional initiatives such as touring and regional arts fellowships.

In addition to state and regional arts agencies, there has been a remarkable growth in the number of local arts agencies in the past 30 years, from 155 in 1965 to over 3800 today. While federal funds decreased since 1991, local arts agencies' budgets have increased an average of seven percent each year. And, a group of national arts service organizations has come into

being — assisting theaters, dance companies, symphony orchestras, small presses, visual arts organizations and visual artists, media arts centers, film and video producers, folk and traditional artists and opera companies, or representing diverse ethnic constituencies and cultural organizations.

The so-called "Arts Infrastructure" also includes thousands of American arts institutions. In 1993, for example, federal funds assisted over 100 dance companies, 44 literary magazines, 113 professional opera companies, over 200 professional theater companies, approximately 200 symphony orchestras and nearly 150 visual artists organizations. In addition, over 300 primarily minority organizations in America's inner cities and rural areas benefited from federal assistance. While these examples do not illustrate the full range of America's cultural activities and do not include federal grants to individual artists of exceptional talent, we believe that they do serve to illustrate the vast potential of American creativity within the not-for-profit sector.

Selected Examples of Arts and Technology Projects Supported by the NEA

The following grants represent a selected sample of some of the art and technology projects which the National Endowment for the Arts has supported:

- National Arts Education Network: Through a cooperative agreement with the U.S. Department of Education, the Arts Endowment is providing support to the John F. Kennedy Center for the Performing Arts for a National Arts Education Information Network, ArtsEdge. ArtsEdge, currently the only national computer network specifically for arts educators, is a national online service designed to: (a) connect people to people and people to information; (b) to build a "knowledge base" of promising programs and practices, and provide links with other networks in education and in the arts; and (c) to coordinate all of the above through a national hub, responsible for the effective administration of the network.

- *"Arts Wire"*: A program of the New York Foundation for the Arts, Arts Wire is a national online service for the arts community. It links over 500 arts organizations across the nation and is adding an average of 30 new organizations each month. Arts Wire provides immediate access to news, information, and dialogue on conditions affecting the arts today. During the NEA ART-21 conference in Chicago in April 1994, full transcripts of major speeches and summaries of discussion sessions were uploaded from the conference site onto Arts Wire for immediate dissemination to subscribers. Comments and suggestions made on line are being reviewed and considered by the Endowment as part of its 5-year planning process.

- Electronic Assistance for Underserved Communities: The citizens of many states with largely rural populations lack access to large urban centers and depend on their state and local arts agencies to provide "grass roots" access to the arts. The NEA has provided funds to an unprecedented partnership of state agencies, local organizations and statewide assemblies in a five-state region which includes Montana, Nebraska, North Dakota, South Dakota and Wyoming. The purposes of these grants include: technical assistance, organization of local and regional workshops, and on-line networking opportunities. The five-state partnership project, called Art Beyond Boundaries (ABB) began at the grass-roots level to met the needs of rural arts organizations that were on the fringe of programs and informational networks. Within the five original ABB states, only nine cities have populations over 50000. Great distances, sparse population, isolation, severe weather, Native American populations and tourism are their common bonds. The ABB crosses state and regional arts borders to bring rural people from the High Plains Region together. These computer conferences have grown and now include representatives from Missouri, Kansas, Minnesota, Iowa, Wisconsin, Idaho, and Colorado.

- Computer Music Information Project: Through a grant to the International Computer Music Association (ICMA) located in San Francisco, the NEA is supporting the Computer Music Information Project. The project will provide services to composers in three areas: development of computer music resource information and dissemination of compositional software through the creation and maintenance of the ICMA software library, a catalog or library that can be accessed nationally by composers via electronic mail; creation and production of a new ICMA compositional research video, containing recent compositional research information on computer music; and publication of the ICMA directory and ARRAY, a computer newsletter that includes a calendar of computer music-related events and information on new hardware and software products available commercially.

- Computer Mapping Tools in Inner-City Schools: Through a 1992 grant to Boston designer Barbara Barros, Boston high schools will have easy-to-use computer mapping tools which will teach inner-city students to sketch and map their local urban environment and to learn urban design analysis skills. This model will eventually be incorporated into the Youth View program of Boston's CityView Network. The project will give students an engaging way to learn basic computer skills and will provide them with visual information about the inner city. Both the participants and the community will learn how the physical conditions of the city can be improved based on the perceptions young people have about their neighborhoods. This project encourages students to become community participants, helping other students and members of their community to take part in shaping its future.

- Fundamental Design Principles for Children: With a grant to the Center for City Building Education Programs in Santa Monica, California, the NEA is supporting "Portable Effects," an interactive videodisc and software program to introduce children to fundamental design principles through everyday objects. Using the urban environment as a focus for integrating math, science, language arts, and history, the City Building Education Program believes that inventive thinking and problem-solving skills associated with the practice of architecture and design can be fostered in young students. The video will be distributed throughout a network of schools and through educational software catalogues. Training will be offered to teachers and school administrators throughout the United States.

- Public Art Seattle: Through the Seattle Arts Commission, the NEA supports Public Art Seattle, an innovative public education feature of the city's public art program. Using a new interactive software technology from Apple Computer, information about the city's 2,000 public artworks will be made available in high resolution images and text at specially designed kiosks at branch libraries, hotels, the convention center, shopping malls and community centers. An audio playback component will be incorporated into the system to offer explanations of the artworks by artists, designers and historians, and projects which incorporate sound as an integral part of the art itself will be included. A CD-ROM version of the entire collection will be created for mass production and national and international distribution to schools, libraries and arts institutions.

- Graphic Design Resources: Through a grant to Indiana University, the Lilly Library's collection of graphic design history will be documented and made accessible with interactive software. The collection is a world-famous repository for graphic design and the printed word. In addition to rare books and historic manuscripts, the collection includes sheet music, film posters, atlases, maps, photographs, book jackets, games and children's books.

Two grants, one (in 1992) to the *Cooper Union for the Advancement of Science and Art in the City of New York* and another (in 1993) to the Rochester Institute of Technology in Rochester, New York, support the development of a National Graphic Design Archive as a collaboration among the

Cooper Union, the Rochester Institute, and the University of Illinois at Chicago. Using graphic design collections as a resource focus, the archive process will transform material housed in institutions throughout the U. S. into electronically accessible visual imagery. The archive will make the in-depth study of graphic design history available to students and teachers nationwide. Moreover, the technology as well as the methodology will serve as a prototype for electronic textbooks for other fields and topics with similarly limited access to study of the original material.

- Digital Images from American Museums: In 1993, the NEA awarded a grant to Harvard University's Fogg Art Museum to support the development of a computer imagebase to document the paintings collection. Considered one of this country's finest collections of European Old Master, 19th century and American paintings, the Fogg Art Museum houses some 1,800 pictures. The project will first convert the Museum's existing mainframe database into a format retrievable on personal computers and then enhance some 300 object records by adding digitized images.

A 1993 NEA grant to the *Corcoran Gallery of Art in Washington, DC* supports the design and implementation of a computerized digital image database to house information on the collection of American and European paintings and sculpture at the Corcoran Gallery of Art. In an effort to modernize and make more accessible its collection records, the Corcoran intends to produce an electronically published catalogue which pairs documentation on each object with a digitally enhanced image. Arts Endowment funds are paying for purchase and installation of the software and for the production of digital images.

The Arts and Humanities on Public Television: Twenty Years of Cultural Programming

The National Endowment for the Arts and the National Endowment for the Humanities have helped provide access to our heritage by their support of broadcasts on public television. Since 1976, the two Endowments have supported over 1,000 television programs in 31 series. Viewers have been able to see Baryshnikov dance, Seiji Ozawa conduct, Jessye Norman sing, Alan Lomax discourse on folk music, Pinchas Zukerman play, Georgia O'Keeffe reminisce, and Max Roach play the drums. This medium has brought historical series such as The Civil War and the Adams Chronicles into the living rooms of millions of American homes. The quality of the programs supported with federal dollars has been publicly acclaimed virtually everywhere honors are given. A quarter of the PBS audience lives in rural areas and small towns. The vast educational potential of the existing archive — not to mention new works and new series yet to be developed, funded and presented — remains to be fully realized. An enormous amount of high-quality programming waits to be presented to new audiences as well as to an enthusiastic audience which would love to see it again. When these existing programs are adapted and supplemented for interactive viewing, their educational value will be increased dramatically.

Museums and the Institute of Museum Services (IMS)

The Museums Infrastructure

Museums are an integral part of the American educational system and are major sources of the Nation's cultural and scientific information. Teachers rely on museum educators, on objects and on exhibits to teach students in all academic disciplines, to provide training in job skills, and to explore issues facing our world today as well as in the past. America's 8,000 museums care for, educate with, and present more than 700 million objects of our artistic, cultural, and scientific heritage. They are also the leaders in interactive educational exhibits.

Museums serve not only as repositories for rare or significant artifacts, but they also have a vital role as centers for scholarly research. Museum curators are significant contributors to the nation's scientific and cultural dialogue, and help preserve national, regional and local identities.

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Museums attract over 600 million visits a year. They are located in every rural and urban area of the country, serving all segments of the population without imposing any economic or educational requirements. In many cities and towns, they are a powerful magnet attracting tourists and visitors whose stays add valuable supplements to the local economy. A survey by the American Association of Museums in 1989 found that museums employ 92,000 full-time workers and another 56,000 part-time employees. Perhaps an even more significant gauge of their importance to their communities is the extent to which paid staff are greatly outnumbered by the 356,000 volunteers who annually donate time and energy to local museums.

In addition to the applications underway at the National Gallery and the Smithsonian Institution, the Endowments and the Institute of Museum Services provide grant support for applications at many private and public museums throughout the country. While both Endowments support museum exhibitions, the Institute of Museum Services is the only federal agency that provides general operating support for museums, and its mandate extends beyond the arts and the humanities to embrace every type of museum including science museums, zoological parks, and botanical gardens. The IMS is especially interested in supporting information technology to improve communications among museums and other educational institutions. Three quarters of all objects in American museums are natural or living materials, anthropological and archaeological collections. The American museum community is committed to linking these collections through the NII as well. These collections, the knowledge of the scientists, curators, and other professional staff, as well as the print, visual, and research materials in their holding may become accessible to even more people through networks of communication outside the museum and classroom walls.

Internet utilities such as World Wide Web (the part of the internet that makes possible the distribution of audio, video, graphics and photographs as well as text) and Mosaic (the software used by most people for access to the Web) provide vehicles for museums and individual artists to present their information to the public over the Internet. Several museums have been able to use gopher servers (computer bulletin boards which direct users to information) to provide information to Internet users on current exhibitions, schedules, and directions to museums. Museums worldwide are producing "virtual tours" of their collections.

Electronic technology is transforming museum practices and is opening new opportunities for educational programs. The National Gallery of Art is developing an internal database featuring high-resolution images and detailed curatorial information on each item in the collection. The same high-quality images will be used in another program designed specifically for the general public's use in the galleries. Already, CD-ROMs are giving home computer users access to many collections. For example, CD-ROMs issued recently include: "Masterworks of Japanese Painting: The Etsuko and Joe Price Collection" published by Digital Collections Inc.; 138 paintings from the Frick Collection published by DCI; and "Art Gallery" featuring more than 2000 images from the collection of London's National Gallery published by Microsoft.

Selected IMS Activities

- The Texas Association of Museums: With grant assistance from the Institute of Museum Services, Texas museums are now linked by an in-state network, making professional resources, comprehensive information on exhibitions, and other materials available online.

- *"New Orleans Neighborhood Development"*: The Historic New Orleans Collection has developed an interactive program with maps, photographs, and city documents from 1800-1960. The program provides interactive tours of neighborhoods to help museums, archives, and individuals do property research in order to find historical building plans, obtain permits for new buildings, and other aspects of city planning.

- Harvard University Biodiversity and Biological Collections Gopher: Contains entire databases of catalogue information from systematic collections at Harvard's Museum of

Comparative Zoology and the Grey Herbarium and other Harvard arboretum and herbaria collections as well as images from these collections.

Other Museum Activities

- The Museum Computer Network: A non profit organization dedicated to fostering the cultural aims of museums through the use of computer technologies. MCN sponsors special interest groups in archeology and ethnography, art museums, Internet, information system managers, small museums, visual information, and vocabulary and cataloging. MCN actively supports standards for automated recording and retrieval of museum information and is working towards creating mechanisms for interchange of electronic information in museums. SPECTRA is MCN's quarterly publication.

- CIMI, the Consortium for Computer Interchange of Museum Information: This is composed of organizations in the United States, Canada, and Europe that are collaborating to promote an open standards-based approach to the creation and interchange of information relating to the professional and business activities of museums and cultural heritage organizations. In May 1993 they issued a Standards Framework for the Computer Interchange of Museum Information.

- The Getty Art History Information Program's Museum Image and Information Standards Project: This consortium will address the standards needed to guide the future of digital imaging for the arts and humanities: the quality required for scholarly research, the information needed to identify images, and the right issues that improve or impede access.

- The Association of Art Museum Directors: They have recently created an Internet news group, AAMD-L, to encourage conservators, educators, curators and registrars to exchange conservation reports, exhibition schedules, and other information leading to time- and cost-saving standardization of forms and practices, and pioneer collaborations on publications over the Internet.

- Interactive Computer Modules in Museums: The NEH has supported a number of interactive videodisc projects in conjunction with exhibitions it has funded.

  A current project, *"Windows on Richmond,"* uses computers and a database of images from a large collection of historical photographs to allow visitors to compare past views of Richmond with Richmond today.

  An exhibition at the Illinois State Museum on domestic life in Illinois included interactive computer stations entitled *"Voices and Choices"* in each section of the exhibition. By touchscreen visitors could put themselves in the "shoes" of people from the past and confront some of their life choices.

  Computer stations in *"The Peopling of Pennsylvania,"* an exhibition at the State Museum of Pennsylvania and the Balch Institute for Ethnic Studies, allowed visitors access to information about the lives of 200 historical personages. An exhibition in the planning stages at the Computer Museum in Boston will use computer technology almost exclusively to explore the ethical, social, and cultural implications of "The Networked Society." As part of the exhibit the Museum has created a Gopher server that will allow remote visits by anyone with access to the Internet. Remote users will be able to access the Museum's exhibit text, images and interactive software.

  A recent award to the *Yeshiva Museum* in New York will use "virtual reality" to transport exhibition visitors into the interiors of ancient synagogues. The exhibition will travel nationally.

Other Federal Agencies

- Smithsonian Institution: The Smithsonian Institution is actively engaged in the new

technologies and is conducting numerous projects which improve its technical capacity, extend its museums' reach around the world by making some collections accessible on the Internet, and create programs that are available to the public. The Smithsonian has embarked on some private sector partnerships to achieve these goals. The Deputy Assistant Secretary for External Affairs leads an institution-wide working group on technology.

- Kennedy Center: The John F. Kennedy Center for the Performing Arts has taken a leading role in arts education issues and is designing and operating an on-line information network called ArtsEdge discussed above. ArtsEdge maintains an "information gallery" with profiles of existing arts education programs and is developing an annotated on-line directory of video resources available for arts educators.

- Library of Congress: The Library of Congress would like to establish, in collaboration with other major libraries and the academic and philanthropic communities, a National Digital Library, the "electronic library of the future." It will not be a single entity, but actually multiple libraries throughout the nation and world linked electronically. This National Digital Library will operate in two realms. First, the national digital collections will comprise a body of materials in digital form, some of it converted from library collections in traditional formats and some of it digital in origin. The converted material will come from libraries and other archival institutions all across the country and will be accessible to anyone anywhere with a computer linked to the international networks. Initially, the unique and historically significant collections in libraries — those most needed for educational and scholarly purposes — will be targeted for digitization and inclusion in the national digital collections. The second realm of activity relates to national digital library services, in which libraries cooperatively find new ways to catalog and preserve digital research files, provide information networks of new scope and effectiveness, and construct new mechanisms for dealing with the intellectual property rights of the creative community.

- Department of Education: In February, 1994, the Department of Education issued Arts Education, A Research Agenda for the Future. It identified the use of media and technology as one of the several trends in American education likely to have a significant impact on efforts to improve teaching and learning in the arts and humanities subject areas. Project ARTS (Arts for Rural Teachers and Students) is a consortium headquartered at Indiana State University and working closely with other sites at Converse College, South Carolina and New Mexico State University to implement visual and performing arts programs for students in grades 3-5 in underserved rural disadvantaged and/or ethnically diverse areas. One of the major objectives of this grant is "to include the use of new technologies to encourage communication and exchanges of locally developed curriculum materials between schools at all program sites."

PART III: Where Do We Want To Be?

Government and the private sector, as well as the nonprofit educational and cultural sectors, have a deep interest in an educated American citizenry. The humanities, arts and museums will provide much of the educational and creative content on the NII and the exciting and interactive teaching tools to reach children in and out of school. The NII is uniquely suited to present the diverse cultures of our country; to foster better understanding and even appreciation of our differences as well as what brings us together.

Government investment already is a major factor in the innovative use of new technologies by the cultural sector. Artists, scholars and museum experts can continue to advance the entire field if they are supported to communicate electronically, experiment, build databases, and present material in exciting, interactive ways to children and the public.

The cultural sector needs public and private investment to digitize collections, so that the

building blocks of knowledge (written, visual and oral - and encompassing the broad range of cultures and points of view) are freely available to the public. Without a continued investment, the public will receive only such cultural information as the commercial sector chooses to present. Ultimately this would hamper the ability of specialists and the public to do original research and to create new works.

The NII challenges us to determine how best to use technology to foster the growth and dissemination of knowledge and to link communities of informed citizens. This challenge will require imagination, content, context, and interpretation, which are essential ingredients of the arts and humanities. With foresight we can use the integrative powers of the NII to build communities, improve our educational system and reach the youth who are currently alienated by formal education, and preserve our cultural heritage for future generations. The powers of this new technology must be matched by bold thinking.

Short Term Projects

Federal Cultural Agency Electronic Capability

All the federal agencies with cultural programs and grant programs are at different levels of technical capacity themselves. Some cannot communicate electronically with applicants or grantees or even panelists and staff. The agencies need to develop their own internal systems to better serve constituencies and set a good example for the nonprofit organizations.

Developing and Expanding Networks

Early experience with the online media has shown that most Americans, cultural organizations, artists, scholars, and citizens have a great deal to gain from being able to communicate about ideas and issues and problem in the arts and humanities. On-line services for cultural information exchange, such as Arts Wire, urgently need to be expanded and made accessible and more affordable to more subscribers.

Public Arts and Humanities Demonstration Projects

The NII is the logical host for increasing the cultural conversations so essential to sustain participatory democracy and community. An accessible NII has the potential to strengthen the position of the artist and humanist in the community and encourage the continuity of cultural traditions.

The NEH, the NEA, and IMS should be encouraged to develop national demonstration projects that use new technologies in creative and experimental ways for public humanities, museum and arts programs. The National Endowment for the Humanities has recently announced its intention to sponsor a new initiative, the "national conversation," on the topic of cultural pluralism and our civic culture. The NII could provide an appropriate electronic forum for this and other "town meetings" in the future.

Demonstration projects might include planning grants for the creation of interactive learning centers housed in public institutions, such as libraries, museums and performing arts centers. Ideally, NII demonstrations would link the resources of these institutions to stations in schools, shopping centers, and living rooms. Museums, for example, could provide access to information about permanent collections (such as the Micro Gallery project at the National Gallery of Art), with biographical, iconographical, and cultural information about individual artists and works as well as customized thematic "tours" of the collections and the physical plant of the museum. Other learning centers could feature humanities CD-ROMs on a variety of literary, historical, artistic, and cultural topics, perhaps with an option to go "online" to get more current information or to communicate with other repositories.

Long-Term Projects

Digitization of Cultural Collections Project

Public and private investment is needed to create, preserve, and make available in digital format America's diverse cultural heritage: its art, its archives, its libraries. We need to make the building blocks of knowledge accessible not only to scholars and artists but to the general public to research, combine in their own ways, and contribute their own knowledge. The federal government should not decide what constitutes this critical mass of information but should invest in enough projects to include the depth and breadth of American thought and culture. If the NII succeeds in reaching all Americans, it will provide virtually instantaneous access to an enormous quantity and variety of information — the diaries of ordinary Americans as well as the papers of statesmen, videotaped performances, folklore collections, and a wealth of databases, newspapers, and photographs. However, the ability of this exciting new technology to convey this complex heritage will be strictly limited by what is available in digital form. Our society needs an investment in documenting its cultural heritage comparable in scale to the Human Genome Project or the Biological Diversity Documentation initiative.

The costs of retrospective digitization of our nation's cultural collections will far exceed the capabilities of the nonprofit institutions which care for and transmit this priceless heritage. At a time when these institutions would like to be investing millions of dollars in new technologies and digitizing existing collections, many are struggling to keep their doors open and to meet rising operating expenses. Dance companies, to take one example from the performing arts, are often the sole repositories of choreographers' notes and staging instructions. Today, most American dance ensembles do not have the ability to preserve, even by using current video technology, an adequate record of the works they commission and present. In fact, many dance companies remain solvent only by extended touring, often abroad, to raise funds to pay their companies. Museums, historical societies, and research libraries are hardly in better shape. Colleges and universities have resorted to tuition hikes to supplement income from endowments and to balance budgets. Many art museums report operating deficits, and although endowment funds for all museums have increased in the past decade, income from these funds has failed proportionately to keep up with increasing expenses. Operating support provided by governmental bodies also has declined significantly in recent years. Independent research libraries -- where much of the nation's most valuable texts and resources are housed -- are in an especially precarious financial state, and many balance their budgets only by drawing from endowments. Reports from library associations emphasize the long-term financial threat to these and other repositories. Clearly, our nonprofit institutions in the arts and the humanities are in no condition to shoulder the massive costs of digitizing these collections. Leaders in the nonprofit sector of the arts and the humanities worry about stabilizing their current operations. If our nation's cultural legacy is to be preserved and advanced, new financing is needed.

Education and Training Initiatives

Education and training in the uses of digital technology for creating, presenting or preserving art and other cultural artifacts should be facilitated. We fully support the immediate objectives and long-term goals expressed in "A Transformation of Learning: Use of the NII for Education and Life-Long Learning," of *Putting the Information Infrastructure to Work*. Implementation of these goals will ensure that our nation's schools will be properly equipped and connected to take maximum advantage of the capabilities of the NII. The NII can offer information, communication, and learning opportunities that meet high standards of quality and help America reach the National Education Goals. America's educational and arts infrastructure represents a vast amount of high-quality content available for distribution over the NII — not only to our nation's children, but to their parents as well. Access to our nation's cultural institutions is as important as access to centers of

scholarship such as libraries, universities and research facilities.

Pilot Projects in the Humanities and Arts for Educating At-Risk Youth should extend mentoring and the infrastructure to provide interactive access points for those without network access. Interagency collaborations and partnerships which use digital technologies in conjunction with the arts to help combat the nation's social challenges — such as crime, violence, and misunderstandings between races and ethnic or cultural groups — should be encouraged. The National Endowment for the Arts already provides funds to non-profit arts organizations with youth programs, including the Manchester Craftsmen's Guild in Pittsburgh, Jazzmobile in Harlem, and Self-Help Graphics in Los Angeles. These and other organizations provide free, professional-level music and visual arts training to inner-city youth. With appropriate NII facilities these organizations could reach more "at risk" children and teenagers, while electronic linkups could enable these centers to share resources and ideas.

State and local agencies already have launched promising new programs which need replication. For example, under the leadership of Mayor Wilbur Smith in Fort Meyers, Florida, a program called *STARS* (Success Through Academic and Recreational Support) established partnerships with youth organizations and arts groups throughout the city to place young people identified as "at-risk" in existing programs. When the STARS program began, only one quarter of the 2000 students involved had a grade average above C. Today, 3 years later, 80 percent of these participants have a grade of C or better. Juvenile crime in the city of Fort Meyers decreased by 20 percent over the last 3 years, while the youth violence rate in the country increased. The U.S. Conference of Mayors recently called on the federal agencies to create STARS-type programs across the country. The NII could serve as a vital link between local governments and arts agencies in spreading this and other useful models. Plus, the NII could be the vehicle for young people to share their experiences and their works with others, and to find on-line mentors.

The NII could help expand the partnership between the National Endowment for the Arts and the Corporation for National and Community Service's *Americorps National Service program*. The Writers Corp, a literacy project administered by local arts agencies in three cities, will involve authors and youths and could be greatly expanded by the use of the NII to link other arts agencies and localities.

National Initiative to Develop Software for Classroom Use

The NEH intends to undertake a special, three-year initiative to support the development, testing, and evaluation of pedagogical software for enhancing teaching in the humanities. The initiative will also prepare teachers to make effective use of the new technologies in strengthening their teaching of humanities topics and in extending access to new student audiences.

Research and Demonstration Projects on Access to Digitized Resources in the Arts and Humanities

An important step in the development of the NII would be the capacity to fund a series of pilot projects to enable selected groups of artists and scholars to experiment with a representative corpus of scanned materials significant to their disciplines. Technical experts would work with the artists and scholars who would then be in a position to recommend the software and protocols that will be necessary to help ensure that digitized resources will meet the distinctive needs of each area.

Census of Digital Resources

Scholars, artists, and librarians at hundreds of institutions across the nation have created local databases of digitized materials in the arts and humanities. There is an urgent need for a census of these materials to promote wider access to these resources and avoid costly duplication of effort. The census would provide a listing on the Internet of what materials have been digitized,

where they are located, and how the material is represented (i.e., text, graphics, moving images, etc.).

Development of "Navigational Tools"

To move the user to the center of this new universe of information — requires the development of navigational tools which go beyond Gopher, Mosaic and other tools we know today.

Electronic Libraries

Another important "next step" in the development of the NII would be the capacity to support a pilot project that would demonstrate what will be necessary to design a prototypical "virtual library" of the future: its governance, organization, economics, and educational functions, as well as its technological infrastructure. Although there is much talk about the "virtual library," there has been little research or actual engagement with the complex set of issues that must be resolved before such a library can become a reality. Emory University is now preparing to embark on a project, in cooperation with Harvard and Yale, to explore these issues and implement a working model for sharing digitized collections from these three institutions. The findings from this project could then be translated to other consortia of research libraries, public libraries, archives, and historical societies.

Standards and Procedures for the Preservation of Knowledge

There is also an urgent need to support demonstration projects that will define and promote shared methods and standards for the production, storage, and distribution of digital images. The computerization of cultural projects and materials, viability issues, plans for long term maintenance and distribution must be coordinated. Any database developed without thought for permanence and reusability of the data and images ultimately constitutes a net loss, not a gain of information. Without the experience gained by these pilot projects, we will lack the basic building blocks for an effective NII. Already, tentative efforts are underway to coordinate digitization projects. For example, there is now a group of 11 universities that have formed a Digital Preservation Consortium (UC Berkeley, Columbia, Cornell, Harvard, Michigan, Pennsylvania State, Princeton, Stanford, USC, Tennessee, and Yale) to explore these issues, but they have not been able to secure the financial support necessary to accomplish this work. In order to ensure that a comprehensive range of cultural material is available and accessible on the NII, it is essential to build digital resources. There remain questions to be resolved:

- What are the definitions of quality for visual and aural image collections? What level of resolution is adequate for online viewing? Are there different levels for different disciplines?

- What kinds of documentation are needed to accompany visual and aural images?

- What are acceptable compression standards for distribution?

- Sufficiently high bandwidth and speed must be assured to meet the needs of artists and cultural institutions. Without an ability to present high-resolution images, full-motion video and multi-channel stereo sound, museums and other cultural institutions will not be able to transmit images or sound that is faithful to the full quality of the art they present. For research purposes scholars in art history or musicology will want the highest fidelity possible, as will audiences and performers.

- A critical issue for both the audio and video industries is the development of universal/global headers that will allow the seamless, interactive, user-driven transfer of information across all networks. For audio, the information might include number of channels, audio sampling rate, style of encoding, alternate channels (languages) available. The header may also be required to carry some information about the history of the program. For video, the information might include the type of video received (e.g., PAL, NTSC, SECAM, CD-I), the size of the

enclosed data packet, compression type, copyright information, and software algorithms for decoding.

Development of universal headers will facilitate the integration of all end platforms from HDTV to PCs. This type of addressing will preserve the options for high quality audio and video, ensure user choice, and facilitate seamless processing without user intervention.

- Switched Network and Capacity and Spectrum Reservation Studies are necessary to explore how a switched network can successfully serve the needs of the cultural sector, especially the nonprofit arts and cultural institutions. Guidance is needed on how to develop meaningful access for non profits on the NII. What will netcasting in the public interest mean/require in a switched network? What is "appropriate capacity" in a switched network? By what gauges should the public interest be measured?

  In some areas it may make sense to set aside portions of the spectrum for alternative programming, such as public access or cultural presentations.

Federal Copyright Laws

Dialogue which might lead to solutions to major issues of concern to authors and artists such as the protection of intellectual property rights, fair compensation and universal access should continue to be actively promoted.

The challenges to copyright law presented by new technologies are numerous. The health of our intellectual property industries depends on the structures implemented to protect the rights of the creative community and its institutions. New media, which allow the use of music, video, still images, and text, raise questions about copyright law and contracts. The granting of rights for future technological developments is of particular concern. The uncertainty in this field is inhibiting acquisition and uses of images and texts.

PART IV: How Are We Going To Get There?

The Federal Government can promote and facilitate partnerships between public and private sectors which ensure that:

- Technology developed by federal laboratories is transferred and used to nurture intellectual property and the cultural sector. Conversely, digitizing cultural information, and supporting the works of scholars and artists will produce technology transfer back to industry.

- The Humanities, arts and museums receive enough investment to acquire technology tools, share their collections and knowledge, and develop their future creative potentials.

- There is a planned, well structured process for setting technical standards, to present quality cultural information, imagery and sound in consistent format, yet does not exclude cultural communities from offering their heritage, ideas and works.

- There are enough demonstrations and model projects that develop arts and humanities content, and link the nonprofits with their users and audiences.

By interacting with the cultural sector, the federal government can set a vision, help set national goals, and establish the policy framework for an NII that functions as a new cultural medium itself.

Issues and Questions to be Addressed

Getting Government Cultural Agencies Online

Many of the examples in this paper of how the arts, humanities and museums are using and developing new technologies are results, in part, of federal funding and public-private partnerships. Because the agencies discussed in this paper are and can be such important catalysts, they themselves need to have a greater technical capacity and ability to communicate with the field.

How can the Federal Government ensure that the agencies responsible for developing the arts and humanities and museums and other federal agencies with cultural programs are able to participate in electronic conferencing and developing of electronic services?

Access to the NII

Through the NII, the arts and humanities will be available to Americans in inner cities, rural areas, on reservations and in ethnic communities, in hospitals, schools, libraries, museums, and art centers. People with little or no access to the riches of our humanistic and artistic traditions can learn about them, see and hear them, and create their own ideas and works.

Cultural organizations, artists, scholars and citizens involved in these disciplines will be able to communicate with each other and build on each others' knowledge.

How will the government assure equitable access to the NII, so that all Americans can explore diverse cultures and bodies of knowledge? How will learning centers and cultural organizations obtain the tools to use, interact with and help build the NII? How can cultural organizations and learning centers be NII access points for people in their towns and neighborhoods?

The NII Can Bring People Together

The arts, humanities and museums will contribute to the civic good by helping people understand and communicate about the diverse cultures of America.

What role does the government have to help diverse communities develop their cultural material and ideas to share and explore with others on the NII? How can the NII be used to have informed "national conversations" about all kinds of issues?

Creating a National Cultural Collection

The combined wealth of information in our libraries, museums, and cultural organizations constitute a vast national cultural collection to be made available digitally to people everywhere.

How will the government ensure that our complete cultural history, to the extent practical, is available in digital form? Can digitizing cultural collections, historical and contemporary, occur in a comprehensive, coordinated process? How will collections of all kinds be identified and made available?

Setting Standards

Setting standards will assure consistent, quality information that will be available to the NII, transfer to business applications, and bring our cultural riches vividly to life for users.

How can the federal government best assist the private sector in the development of standards for various classes of information? How can it assure effective coordination among government cultural agencies? What standards should federal, state and local agencies use with their grantees and contractors?

How should the federal cultural agencies address such issues as resolution standards for scanning, digitization, and presentation of images and other graphic materials? What navigational tools can be developed so that researchers and others can communicate across databases?

Learning Through New Technologies

The arts and humanities are an essential part of every child's education, and a part of government's Goals 2000 initiative. Educators find that training in the arts and in the humanities develops discipline, promotes teamwork, critical thinking, ability to make informed choices, and the ability to express one's self constructively and communicate with others. This training also teaches the visual and media literacy that will assist young people to decipher and use the NII.

How will all levels of government include the arts and humanities disciplines in the curriculum? How can the NII encourage the adoption of the national standards established for the arts and for humanities?

How can existing models for teaching these disciplines, for integrating them into the school day and using them to teach other subjects be disseminated? How will models for teaching that use new technologies be supported? How can scholars, artists and teachers be supported to work together to develop educational content and creative presentation in new teaching tools?

Creating Content

The arts, humanities and museums will develop content for the NII. The cultural sector can help develop the NII by creating educational and engaging content that in turn will create demand and participation.

How will the federal government support the cultural sector to build databases and use materials from history, literature and the other humanities disciplines and present the arts in all their variety with their surrounding body of knowledge? What model projects can receive investment to use the technology creatively?

Contributing to Organizational Stability and Reaching New Audiences

In the past 30 years government has encouraged cultural development and has supported an infrastructure of organizations. Colleges and universities, research libraries, dance and theater companies, music ensembles and centers, nonprofit presses, folk life centers, media centers and workshops all are part of the humanities, arts and museums infrastructure across America that assures access by a wide number of people and makes available a diversity of thought, research and art forms. These nonprofits are often small, understaffed, in need of better facilities and in danger of debt. To be part of the Information Infrastructure, they will need assistance.

How can all levels of government and the private sector support cultural organizations to achieve enough stability to acquire the tools and training they need to be part of the NII?

How will cultural organizations of all kinds be able to use the NII to reach new audiences? How can cultural offerings on the NII, such as virtual museums and hypertext, encourage participants to seek out the original experience: to visit a museum, attend a concert, go to a lecture?

How can cultural organizations use the NII to improve management, learn from each other, survey their students, participants and audiences? How can they use it to achieve economies in management, such as storing, researching and publishing information or doing block-booking?

Federal Copyright

How will the Federal Government protect intellectual property rights and ensure appropriate compensation for artistic creations and original scholarship and writing? How can issues of rights and reproductions be resolved so that images do not become the private domain of a select few?

Educating and Training Humanists, Artists and Other Users

Training and educating artists, scholars and other trained practitioners in the arts, humanities and museum community can add to the general store of knowledge on the NII, shape content and even advance technology. Artists, scholars, designers, curators and others need access points and training to communicate and collaborate on new works and experiment with the technology. Educators and managers of cultural nonprofits will need training to use the NII and understand the potential uses of digital technology.

How will the government be a catalyst for training? Will the government and the public and private sectors work together to plan regional labs or access points where training and experiments take place? How will the government encourage educational and other institutions to share technology and become training centers and or access points for the scholarly and creative communities? Can the government and private sector cooperate so that artists and scholars can collaborate with engineers, software developers and manufacturers?

Conclusion

The National Information Infrastructure promises to extend the power of the human imagination to new frontiers, and American artists and scholars will be at the forefront of this exploration. Through the NII the arts and the humanities will play a vital role in creating a new sense of citizenship and community, in strengthening our schools and offering exciting challenges to our children, and in creating new industries and works of art and scholarship yet unimagined.

The NII will provide the tools for bringing the world of the arts and humanities to our nation's inner cities and rural areas. The NII will bring new opportunities and resources to our nation's disadvantaged youth, allowing them to share their ideas, thoughts and creative energies, and to make new links with other young people throughout the nation.

The NII can give all Americans, of all races, ages and locations, their cultural birthright: access to the highest quality thought and art of this and prior generations.

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Acknowledgments

Museum Computer Network
J. Paul Getty Trust
George Lucas Educational Foundation
John Perry Barlow
Linda Bell, IMS
Jeff Berg
Martha Chowning
Karen Christensen
Dr. Elizabeth Cohen
Don Evans
Jeffrey Field
Mickey Hart
Charles Henry, Vassar College
Ellen McCulloch-Lovell
Kent Lydecker, Dept. of Education,
The Metropolitan Museum of Art
Olive Mosier
Barbara Paulson
Malcolm Richardson
Scott Sanders
Marsha Semmel
Mayor Wilbur Smith, Fort Meyers, FLA
Nicholas Spitzer
Keith Stephens
Arthur Tsuchiya

Public Safety and The National Information Infrastructure (NII): Supporting Law Enforcement and Criminal Justice

DRAFT FOR PUBLIC COMMENT

PART I: What Is the Application Arena?

Public Safety

"Public safety" means different things to different people. To the professional living in suburbia, it's home burglary, car theft, and concern about being mugged at the bank teller machine. To the homeless, it's being set on fire while sleeping. To the farmer, it's fear of being shot while driving in the city. To the city dweller, it's random shootings, muggings, and gang violence. To the fan at the ballpark, it's pickpockets.

The cop on the city beat has a very different view of public safety from the Federal agent working an international terrorism conspiracy. Drug smuggling from outside the country is connected to drug violence in low-income city housing projects, but the people who combat them work for different levels of government, have different jobs, and use different tools and techniques.

Public safety is first and foremost prevention and deterrence of violent crime against people and their property. Second, is apprehension and punishment of those who break society's rules regarding such behavior. Together, these have given rise to two major industries. One focuses on security; the other on law enforcement and criminal justice. The National Information Infrastructure (NII) will be important to both, just as it will be important to city cops, Federal agents, prosecutors, judges, and jailers.

Law Enforcement and Criminal Justice

One often hears the term "Criminal Justice System," and conjures images of police officers in blue, judges in black, and prison inmates in stripes. Each of whom are players on a big stage, connected in a centuries-old process or "system" in which each plays a role relative to the other.

It starts with the rules society makes for the acceptable behavior of its citizens and organizations, and the penalties it imposes for those who act unacceptably. Some rules derive from pre-colonial common law, but most derive from statutes (laws), as do the penalties. Taken together, the laws (the "criminal code") define the various offenses against society and their respective penalties. The criminal justice system is the process by which those laws are enforced.

The criminal laws in our nation are predominately a matter for individual states. Each has its own criminal code and its own infrastructure for enforcement. In addition, the Federal Government has laws dealing with matters that cut across state lines or are unique to the national defense or other aspects of the Federal Government. However, in numbers of offenses, offenders, police, judges, and jailers, the state and local numbers dwarf those of the Federal Government. About 95 percent of all law enforcement personnel in the United States work for state and local governments; and of the 17,000 law enforcement agencies in the country, 90 percent have no more than two dozen officers. Half have only a dozen or fewer, and

only about 60 agencies have a thousand or more.

Whether Federal, State, or municipal, the criminal justice system is basically the same. The Congress, legislature, or city council passes laws that establish misdemeanor and felony offenses and their penalties; creates and funds investigative and police agencies that are empowered to make arrests; establishes and funds a system of courts to adjudicate civil as well as criminal cases; and creates and funds institutions and agencies for the punishment and rehabilitation of offenders.

When a person or organization acts in a way that some law says is a criminal offense, the system is brought to bear in a series of connected steps. In its most simple terms, step one is the gathering of evidence of the violation by police or investigative personnel. Step two is the arrest or apprehension of the violator. Step three is the determination of guilt or innocence in a court of law. Step four is the determination of the penalty to be paid if the violator is convicted of the offense. Step five is the execution or payment of the penalty; and step six is the return to society of the offender, usually involving monitoring in a condition called parole.

Prevention and Deterrence

What we really mean when we speak of "public safety" is the ability to live our daily lives without fear for our personal safety or the safety of our loved ones, and without fear of the theft of or willful damage to our property. Society seeks to minimize those fears in two ways. One is in the certain apprehension and punishment of offenders, and the other is through a variety of strategies for the prevention and deterrence of crime.

Whereas the criminal justice system exists to apprehend, punish, and rehabilitate offenders, "public safety" depends heavily on the countless daily actions of individuals, groups, and governmental agencies to make our homes, neighborhoods, and communities safer. Some of the ways we deter crime other than through the criminal justice system are through barriers to entry into our homes, automobiles and offices; neighborhood "watches" or patrols; lighting of streets and sidewalks; security screening in airports; and the simple presence of police officers on our streets and security guards where we gather. We also educate our children about which behaviors are permissible and which are not, about how to avoid victimization, and about the penalties for violating the criminal laws. That education has been enhanced and extended recently by public-service media advertisements featuring the McGruff "Take a Bite out of Crime!" figure.

Nowhere does the expression, "an ounce of prevention is worth a pound of cure," apply more than in the realm of public safety. Because of the attention being paid to information technology and telecommunications in the criminal justice system, it is easy to overlook the less structured and governmentally sponsored realm of prevention and deterrence. Yet the latter may prove ultimately to be a most fruitful area for NII investment and targeting. Thus, the public safety application arena for the NII must encompass such prevention and deterrence techniques as detection and signaling of intrusions, screening of persons who are acquiring certain kinds of guns, and citizen involvement in crime-solving.

Prevention and deterrence is itself an enormous application area in the NII. A whole industry of manufactured devices has been created in the span of a couple decades, and another industry of security services based on telecommunications has also arisen. It has been estimated that, nationwide, we are spending at least $50 billion on private security, and that the industry employs about 1.5 million people, including about 900,000 who work as security guards.

Throughout the land, the "911" emergency number is making every telephone an instrument for potential crime prevention and deterrence, in addition to summoning help when a crime is committed. As portable telephones and personal communicators enter the scene, anyone walking down the street or lying on the beach may deter crime simply by the display of a device that can summon police and cause a crime description to be recorded. Criminals seeking targets of

opportunity may pause at the sight of the phone in the hand of an intended victim or bystander.

Who Are the Parties in the System?

Of all areas of society, the criminal justice system probably comprises the biggest array of organizations and job descriptions. What ties them together are structured flows of information. Not unlike a raw material for a manufactured product, an offender passes through one stage after another, from one custody to another. All that the stages have in common are offenders and the information that accompanies them.

The first parties to deal with criminal offenses are the line officers of the local police and county sheriff departments, state highway patrol, park rangers, drug enforcement agents, and other Federal, State and local law enforcement agencies. Their investigations are supported by forensic scientists and technicians, and the records and data processors who operate fingerprint files and computer data banks. The criminal cases they prepare are turned over to prosecuting attorneys who work for whichever government's law has been violated. The prosecutors interact with the opposing defense attorneys and with the personnel - magistrates, examiners, clerks and judges - who staff the courts.

If the criminal case goes to trial, ordinary citizens are summoned to be jurors and witnesses; and if the case results in a conviction a new set of organizations and people enters the stage. They include pre-sentencing examiners, corrections officers and managers, and parole boards and officers. All together, about 1.65 million people are employed in the nation's many criminal justice systems.

Overseeing the systems are countless non-governmental organizations, legislative committees, academicians and researchers, and concerned private citizens. What they and all the system participants have in common is the reliance on certain kinds of information, and the timely and complete communication of that information.

Like a delicate machine with many interacting parts, the criminal justice system poses great challenges for its planning, funding and management, not only within jurisdictions but also between them. Increasing the numbers of police and investigators without increasing prosecutors can mean that offenders will escape punishment because their cases will not get to a courtroom. Increasing police and prosecutors without increasing judges and court personnel can mean that cases may be dropped or dismissed because the judiciary can't process them. Increasing all of these without increasing prison capacity can mean that offenders will be returned to the streets too soon for lack of space in which to incarcerate them.

Some Dominant Issues

Resource Allocation

The overriding issue in public safety today is where governments should allocate their scarce resources in order to achieve acceptable levels of safety for their citizens and businesses. While this is very much a matter of perception and emotion, the NII can play a positive role by fostering investments and technologies that let people feel more connected to police and others to whom they look for protection against crime. Portable telephones and communicating devices that can summon help at the press of buttons may have a profound effect on public safety everywhere.

A specific resource allocation question is what tradeoffs to make between hiring more criminal justice workers and equipping the existing workforce with more powerful information technologies. After all, telecommunications and information, in combination with physical evidence, have become the sine qua non of the fight against crime. Few criminal offenders are apprehended in the process of committing their crimes, and few police officers arrive at crime scenes by pure serendipity. By leveraging investments in information technology and infrastructure, the NII can help governments across the country realize a greater return on their scarce dollars.

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When it comes to governmental budgets, each jurisdiction is affected by what others choose to do. The effects are not confined to interplay between cities and counties over which will patrol what roads, or between two states wishing to prosecute an offender who committed crimes in both. They extend also to such resource allocation decisions as whether to invest in automobiles or laboratories or radio systems. Two neighbors may have different priorities, as may cities and their respective states.

Recidivism and Crimes While Awaiting Trial

Public safety professionals in almost every jurisdiction are struggling with how to prevent offenders from committing subsequent offenses. Considering how may crimes are second, third, or fourth offenses, the issue cannot be overstressed. The recent spate of "three strikes and you're in" laws confirm this. It is interesting to note how great a role information and its processing is playing in efforts to combat recidivism. Offender criminal histories, analyses, and even "artificial intelligence" techniques are being brought to bear not only on sentencing and parole determinations, but also on pretrial release of persons who are felt to pose a significant risk of committing additional or subsequent crimes. The NII can enhance these efforts by enabling more relevant information to be focused on such determinations in a more timely manner.

Citizen Involvement

How to foster and use the involvement of individual citizens is a third key issue. It takes many forms, from simple precautions aimed at discouraging crime, to testifying in court. The NII can foster involvements by delivering multimedia education, and multimedia information about criminals and their crimes; and also by creating an infrastructure to enable citizens to summon help more quickly and in a wider range of circumstances.

All Segments of Society

The fourth issue is closely related, namely how to provide comparable levels of safety to all persons, regardless where they may live, work, or play, and regardless of their income. To be truly "national," the NII must support public safety services to everyone at costs they or their local governments can afford. The National Center for Missing and Exploited Children is posting pictures of missing children on the Internet, but those children may be located in city neighborhoods or remote countrysides where no one has ever heard of the Internet, much less use it, either now or in the foreseeable future. The pictures need another route to the populace besides the Internet.

Knowledge versus Privacy

An issue that has been with us for a long time and will continue to influence our decisions is the tension between the public's right to information affecting the public health, welfare and safety, and an individual's right to personal privacy. Part of the NII will be new mechanisms for creating databases and information repositories, and sharing and using them in new ways. The tension will play out in both the technological and political arenas. One of the greatest challenges for the NII will be to ensure protection of personal privacy in an infrastructure that by its very nature is oriented to maximize the disclosure and availability of information about all things, including individual citizens.

Potential Benefits of Improved Information Infrastructure

Crime is expensive. Estimates place its yearly cost to U.S. society at $163 billion, or almost two-thirds of what we spend on national defense. Individual victims pay some of those costs, while governments and their taxpayers pay by far the larger portion. Unlike such other application areas as manufacturing, commerce, and libraries, there is no investment leverage from fighting crime. All that is gained is a reduction in costs.

Because those costs are so enormous, even modest reductions can yield considerable benefits. Two examples readily come to mind. One is prison construction, which has become the fastest-growing segment of state budgets. If

the nation did not have to contend with an inmate population that has tripled since 1980, these sums could be spent far more productively on such infrastructure improvements as roads and telecommunications. Although the prison construction is necessitated partly to replace aging facilities, both the states and the Federal Government are creating the space primarily to incarcerate new and repeat offenders for longer periods of time, in response to increases in the incidence and prosecution of crime.

Another example is the recent history of adverse effects on the tourism industry in southern Florida as a result of crimes committed against visitors from abroad. In an era of ubiquitous, fast, and relatively affordable travel, people from around the globe are visiting the United States. Perhaps the only noneconomic condition that will discourage this travel and its economic benefits to our country is the fear for a visitor's personal safety.

Information infrastructure used to support the war on crime holds the potential for cost reductions in many ways. When it plays a role in fighting organized crime, including international cartels, and in reducing the flow of illegal drugs into the country, its result may be the redirection of tens or hundreds of millions of dollars from crime bosses and their underlings in other nations to honest citizens and their businesses here in the United States.

To the extent that the information infrastructure contributes to reductions in crime against individual citizens, it may yield the greatest benefits of all. Apart from simply feeling safe and secure in one's home and place of work, in travel and recreation, and in conducting the daily affairs of life in a community of people, the benefits are strongly economic. Crime against property results in costs to repair or replace, and in lost business and wages. Crime against people costs not only in medical expense but in lost productivity and in the need for social services. Together, these costs in the United States are estimated to approach $20 billion. NII investments to reduce such costs are bound to be welcomed by the American public.

How Do We Measure Results?

Public safety offers two ways of describing its condition. One is through an array of statistics about the incidence and costs of crime. Another is through perceptions — how people "feel" — which perhaps is evidenced best by the words and deeds of elected officials and the outcomes of elections. These two forms of measurement do not always coincide. Crime may not be the most important political issue at a time when it is increasing, and, conversely, it may be the electorate's paramount concern at a time when it is actually in decline.

In terms of dispassionate statistics, there are countless measurements of the incidence of crime, the costs of crime, the rates of recidivism, the effectiveness of different strategies of parole monitoring, etc. As new information infrastructure is brought to bear on the incidence and costs of crime and the perceptions as well as reality of safety, it will be reasonable to compare those infrastructure costs with the reductions in the occurrence and costs of crime.

PART II: Where Are We Now?

Broad Trends to Date

Apart from the underlying societal conditions that have given rise to increases in crime, several broad trends have emerged in the criminal justice system since World War II (WW II).

Reliance on Radio Communications, and Mobility

A half-century ago, police officers patrolled city neighborhoods on foot. To communicate with their headquarters, they walked to special call-boxes, which were dedicated telephone circuits to headquarters dispatchers. In a relatively short period of time, radio systems replaced call boxes, impacting, via the automobile, the foot patrol officers who used them most.

Initially, the radio equipment was of a size and weight that required an automobile. Automobiles also let police departments respond more quickly to requests for help, and cover larger areas with fewer officers — essential in suburbia. Today, with the development of micro-miniaturization, radio equipment can be worn on an officer's belt, enabling local authorities to rediscover "neiç.ıborhood policing" on foot and even on bicycles. The NII can support this trend, principally through actions in wireless communications.

Public safety as we know it today grew up around radio technology, and depends more heavily on that one technology than all others combined. The National Crime Information Center (NCIC) would be almost meaningless without the radio link between police dispatchers and patrol cars. Without radio dispatching of officers to crime scenes or citizens in distress, communities would be faced with the choice of increasing their patrol forces by perhaps an order of magnitude, or of being unable to respond in time to apprehend criminals, render citizen assistance, and gather essential crime-scene data.

Reliance on "Listening"

While Sherlock Holmes didn't solve crimes by electronically eavesdropping on criminals, today's detectives rely greatly on that technology, especially against crime that involves conspiracy. Organized crime syndicates have been crippled after government informers have worn body microphones, or after its meeting places have been "bugged" by criminal investigators. As criminals have switched to planning their conspiracies via telephone conversations instead of postal letters, telephone wiretaps have succeeded postal interceptions as a crucial technique for preventing crime and gathering evidence.

Ironically, from the perspective of public safety, the NII may be seen as a two-edged sword. On one side, it offers great potentials to law-abiding citizens for the prevention and deterrence of crime; but on the other, its use of digital technology with privacy encryption may force law enforcement to seek new alternatives to wiretapping telephone communications.

Several Federal government agencies have been working hard to reconcile the established crime-fighting power, conferred in law, to intercept certain telephone communications, with the emerging digital technologies and encryption capabilities that could have the practical result of rendering ineffectual the statutory power to record those phone conversations. The agency efforts have given rise to a public discourse that may serve to clarify national policies in this area.

Creation of Shared Databases

Before World War II, law enforcement developed the concept of the shared information file for fingerprint records and criminals' modus operandi. The security environment around WW II and the ensuing Cold War gave rise to centralized files of national security clearance information about individuals. Almost all of this information was in paper dossiers.

With the advent in the mid-1960's of what was called "third-generation" computer and communications technology, law enforcement began to see the possibilities in making important information available instantaneously to criminal justice agencies in multiple jurisdictions. The FBI's National Crime Information Center (NCIC) built new computer databases of wanted persons and stolen property, and constructed an on-line inquiry system to enable Federal, State and local line officers in vehicles and on foot to learn in seconds, e.g., if a particular automobile license number had been reported as stolen. The NCIC now holds over 24 million records in 14 files, that are accessed directly or through intermediaries by over 500,000 individuals in over 70,000 Federal, State and local agencies, using about 97,000 computer terminals to send over a million transactions every day.

On-line computer databases exist now to support practically every aspect of criminal justice, from smuggling and terrorism to stolen art and parole violation. They have been built at Federal, State, and local levels. In one example,

the Los Angeles County Sheriff's Department operates the Gang Reporting, Evaluation, and Tracking System, known as GREAT, containing information on about 1500 street gangs and over 100,000 street gang members, and which is accessed by over 130 law enforcement agencies nationwide.

These systems of shared data have become an essential weapon in the war against crime, because crime and criminals are not confined within political borders. As our society has become mobile, so has crime. The public safety/criminal justice system in the United States is essentially local. The state agencies do what the local agencies are unable to do, and the federal agencies are built around interstate activities. Consequently, the sharing of information across political boundaries is crucial to the public safety picture in the United States.

Importance of Forensics and Science

In our criminal justice system, a person charged with a crime is presumed innocent until proven guilty. Increasingly, that guilt is ascertained from evidence based on scientific knowledge, and analyzed with instruments and techniques unknown a half-century ago. Most prominent recently has been the technique of deoxyribo nucleic acid (DNA) analysis, which has been touted as the 21st Century counterpart to the discovery of fingerprint identification at the beginning of the 20th Century. It will join fingerprints, ballistics, the examination of fabric, hair, ink, soil, paper, etc., and the laboratory analysis of illicit drugs as a major weapon in the arsenal against crime.

Information gathering, analysis, storing, and sharing over computer-based networks already plays a vital role in the application of science and forensics to public safety. The NII offers a significant opportunity to enhance this trend by supplying new bandwidth for the transport of such crime-solving information as images, sounds, and laboratory measurements.

Some Changes Underway

From the perspective of prevention and deterrence of crime, and of citizen involvement, the growth of cellular communications and investments in premises security technologies are bound to have significant impacts. One way of viewing cellular communications is to consider each portable unit to be the modern-day equivalent of the earlier police street-corner call-box.

Meanwhile, the estimated $15 billion market in security devices and systems is encouraging development of new products and services by the private sector. Automobile manufacturers, supported by the insurance industry, are using computer-based technology to build into new vehicles the means of thwarting both car thefts and car-jackings. As to premises monitoring, estimates place the number of active accounts at 15 million, and annual revenues to service providers at $2.15 billion. Among others eyeing that market, utility companies talk about including security sensors that signal criminal intrusions along with home sensors and controls to regulate heating, cooling, lighting, and even cooking.

Another change concerns what is called electronic crime. It rarely enters into discussions of public safety because the latter tend to focus on personal physical safety, while electronic crime is considered nonviolent crime against property. Nevertheless, in the context of the NII, electronic crime, almost unknown several decades ago, may now be costing the nation billions of dollars each year. The losses to businesses and financial institutions are borne ultimately by citizens in the form of higher prices for goods and services. Both increases in electronic crime and in electronic countermeasures against it appear to be unavoidable by-products of the NII.

Within the criminal justice community, perhaps the biggest change underway is the cultural acceptance of information technology as a major two-pronged weapon in the war against crime. One is in direct support of line officers by giving them communications and information access capabilities that equal or exceed those of their criminal adversaries. The other is in improvements to the efficiency of operations within the criminal justice system, as seen in the wiring of parolees to monitor their whereabouts, and in the introduction of interactive video technology in the operations of court processes and of prisons.

Resource Commitments

Besides building more prisons and hiring more police, prosecutors, and judges, governments are making some noteworthy information infrastructure investments in support of public safety. Two in particular have significant NII implications.

Several states have initiated programs to search fingerprint data electronically. Law enforcement agencies have long recognized the desirability of being able to match fingerprints quickly with data already on file, and have been frustrated by the delay in days or weeks that is inherent in a manual, paper-based environment. Consequently, governments are investing millions of dollars in computer, scanning, and communications technologies, and in accompanying data file conversions. Largest among these is the FBI's multi-year program to automate its fingerprint processing operations.

Just this one application holds important implications for the NII. Digitized fingerprints are comparable to digitized photographs or maps or large data files, and will need far greater bandwidth to transmit them than is being used now by law enforcement for such simple data as automobile license numbers and personal identifiers.

The second infrastructure investment — not yet as far along as electronic fingerprint processing but likely in the end to greatly surpass it — is the conversion of the thousands of law enforcement analog land-based mobile radio systems to digital technology, and to the integration of those systems into an entirely new and unprecedented shared wireless infrastructure.

Leading the way is the state of Colorado, whose Digital Trunked Radio System may be the model for the next several decades. Now being developed, it is intended to be a comprehensive system with such functions as dispatch, car-to-car voice, car-to-car data, paging, data dissemination from dispatch centers, and support for portable computers with fax modems. Most important, it will be a statewide backbone linking public safety activities in local jurisdictions with one another and with state agency personnel, facilities, and information services. The backbone will link with Federal data systems such as the NCIC, and with systems operated by other states.

PART III: Where Do We Want to Be?

Wireless Holds the Key

For the nation's law enforcement community, the "last mile," the "information highway on-off ramp," is the wireless link to lonely highway patrol cars in Colorado, to foot and bicycle police officers in Detroit, to park rangers in the Everglades, to border patrol officers along the Rio Grande, to drug enforcement agents in Miami, and to police squad cars in Los Angeles. The most elaborate information infrastructure of powerful computers attached to fiber-optic backbones is only as useful to public safety as the wireless link to law enforcement officers.

From the perspective of law enforcement, "where we want to be" involves two things. First, the ability of line officers to communicate not only with dispatchers, but also with one another must be at least as good in the field as in headquarters offices. It must be as good outside urban areas with their cellular systems as inside them. It must be as versatile on the patrol bicycle or motorcycle or in the highway patrol car as on the desktop at headquarters. Second, information resources useful to law enforcement agents must be made available to

them at times and in places where it will be of the greatest value. Sometimes, this may be at a headquarters office location, but more often it will be in an automobile. Those information resources are changing, and must be defined in tomorrow's terms, not today's. Among them will be a fingerprint scanner and a printer or display that can show a photograph of a person's face, along with a character display for license data, outstanding warrant information, etc. Many law enforcement parties believe that the risk of injury and death to officers engaged in dangerous situations would be reduced by having within the wireless infrastructure the ability to transmit the officers' positioning and body vital sign data.

The same wireless infrastructure that supports line officers of law enforcement could also be used to monitor the whereabouts of persons awaiting trial or offenders released on parole. Inventive entrepreneurs are creating devices which can respond to wireless signals and be affixed to individuals. As this technology is refined, made tamper-proof and extremely reliable, it holds a promise of possible alternatives to incarceration for some offenders. Considering that it costs about $25,000 to house an offender 1 year in prison, electronic confinement or restriction at less than half that cost would be a major benefit to society.

Ultimately, public safety is bound to improve when individuals can alert law enforcement authorities at any time from any place, without complete dependence on the wire infrastructure. We are already moving quickly toward this capability, and the pace is being accelerated by the cellular telephone and security system industries. Eventually, intrusion detection will probably be a feature of all new homes and vehicles, as well as most business establishments.

Other Technologies Can Count, Too

For as long as one can see, fingerprints will continue to be both the principal means of positive identification of individuals and also a crucial aspect of crime-scene evidence. The NII can support the move to bring fingerprint information into the electronic era by facilitating current and planned governmental investments in this public safety information endeavor. New state and federal systems will need to be linked with one another, and infrastructure will need to be created to facilitate such anticipated capabilities as index finger scanners in police automobiles, and electronic scanners of crime-scene prints.

Images and Sounds

In a related endeavor, separate law enforcement agencies are beginning to examine the possibility of developing a common technology for obtaining identification information about alleged offenders at the time of arrest. This activity, known as "booking," involves photographing as well as fingerprinting, and the recordation of identifying characteristics, plus data about the offense, the offender's residence, etc. As techniques that deal with voice analysis are refined, the booking process may include them, too.

Public safety officials anticipate that agreements among jurisdictions and among agencies within jurisdictions will lead to national standards for the multimedia information obtained in booking. This, in turn, is expected to lead to faster, more reliable identification of repeat offenders, to improved crime-fighting across jurisdictions, and to a greater degree of deterrence. In a related vein, multimedia information, particularly images, will surely be integrated with the textual and numeric character databases that are now accessed by law enforcement agencies. Inclusion of image information along with such descriptors as name and date and place of birth may not only lead to increased rates of offender apprehension, but also to reductions in incidents of mistaken arrests.

Possibilities in Video

As great strides are being made in video technologies and their integration into the NII, the picture of where we want to be holds several appearances of video. One is in security.

As it applies to video, "security" is a combination of prevention, deterrence, detection, and even

solution of crime. The use of video security systems in businesses, at places of work, in public accommodations, and even in residences has proven its value in both perceptions of improved safety as well as detection and solution of incidents of crime. The advent of the NII raises some intriguing possibilities for the extension of this technology to new places, such as city streets, playgrounds, and parks. "Neighborhood watch" programs might not require residents to physically leave their houses, and urban housing complexes may be able to be monitored by those who have the greatest stake in that activity.

The other application dimension of video technology is in the day-to-day operation of the criminal justice system. Pilot projects in several states are exploring the use of video in prisoner arraignments. This application promises to reduce the costs of prisoner transportation in more spread-out and less-populated areas of the country, as well as keep prisoners in their communities with their families and attorneys. The pilots are already proving the technology's value in large metropolitan centers, between the city jail and the courthouse, where physical transport is costly, time-consuming, and potentially dangerous.

In general, the criminal justice system favors direct face-to-face interactions and observations. As video technology, including recording, has matured, the courts are beginning to weigh its use, in recognition of its potential benefits. It is probably safe to project an important cost-saving role in the widespread introduction of both video recording and video interaction throughout criminal justice system processes. The NII promises to be a key facilitator of that role.

Electronic Crime

The more business is transacted electronically, the more electronic crime will follow. In fostering electronic commerce, the NII will be opening new vistas to clever criminals. When we think of public safety we think more of physical crimes against persons and property than such monetary crimes as fraud and embezzlement. Yet the two are not necessarily separate. The home that is wired for utility and security controls, plus video entertainment and computer bill-paying, can also be a home that tells criminals when it is empty of people.

As the NII unfolds, we want it to provide protection against crime to go along with the opportunities to commit crime. At a minimum, protection is needed against electronic theft. Additionally, protection will be desired against the use of the communications environment to target victims. To accompany the protections, mechanisms will be needed to successfully detect electronic crime and link it to its perpetrators with evidence that is strong enough to gain convictions in court.

Links to Other Environments

Although the criminal justice system is compared to a finely tuned clock, it does not exist in a vacuum. Deterrence against crime, detection of crime, and prosecution of crime can all involve connections into other environments. One example is the link between law enforcement and the financial community. Because the war against organized crime and drugs is being fought most successfully on the financial front, the more quickly and thoroughly law enforcement knows about large cash transactions, the more effectively it can use the knowledge.

A related example deals with the legal side of narcotics and other controlled substances, which health professionals are licensed to prescribe and pharmacists are licensed to dispense. To enforce the laws, which can carry criminal penalties, state and federal agencies monitor behaviors through careful record-keeping of prescribing and dispensing. Oklahoma, Massachusetts, and Hawaii have been pursuing prototype uses of electronic point-of-sale transmission systems to collect prescription information. These prototypes may point the way towards widespread implementations when the communications infrastructure is in place to support them economically.

PART IV: How Are We Going to Get There?

Planning and Funding the New Wireless Environment

Getting there is going to require a major, coordinated re-engineering of the wireless environment for law enforcement. Not only must agencies within levels of government plan together, they must plan also with their counterparts in other political jurisdictions, especially those of their neighbors. A new wireless infrastructure must be designed and built — one that will provide interoperability among agencies regardless of jurisdiction, that will give as good service to personnel outside metropolitan areas as inside cities, and that will incorporate dynamic bandwidth allocation to enable the bursty transmission of image information to and from mobile apparatus.

How will it be done?

Probably the biggest challenge in creating the desired wireless infrastructure will be its planning. Few precedents exist for the level of interagency and intergovernmental cooperation needed to accomplish this task. Colorado's venture will be watched closely. The RAINBOW Project inter-island microwave backbone in Hawaii is a multi-government, multi-agency success story, but the U.S. Customs Service played the pivotal role.

No one government can fund what must be built nationwide. Individual states will have to step forward as Colorado is doing, but the Federal Government will also have to put its shoulder to the wheel, both nationally and within state borders, if the needed degree of interoperation is to be realized.

The National Performance Review (NPR) has spawned a project to create a new wireless law enforcement environment among federal agencies, with the first action being the creation of a Federal Law Enforcement Wireless Users Group. The project envisions a "National Law Enforcement/Public Safety Wireless Network for use by Federal, State, and local governments," but is that realistic, and if so, when and how? The aggregate state and local needs far exceed the total federal needs. Can the Federal Government solve the states' wireless problems? How will the state solutions dovetail with that of the Federal Government, or should federal agencies become users of the new state networks? Meanwhile, what spectrum allocation strategy should be pursued, and what encryption strategy should be adopted in order to secure wireless law enforcement communications from monitoring and interception?

Military, Civil Government, and Private-Sector Roles

Getting there can be helped by technology transfer from both the military and from the private sector. The U.S. Department of Justice (DoJ) has been working with the U.S. Army to move into the world of law enforcement such technologies as the one being pursued by the Army for its service-wide DNA registration database for identifying casualties. Similar efforts in the realm of wireless communication and its integration with wire-based networks may also promise benefits.

The Army's Surgeon General's office is interested in developing a helmet with audio and video capabilities to permit three-dimensional imagery from the battlefield to base hospitals, supported by vital signs monitoring. Law enforcement officers with such equipment, using new communications infrastructures, might be able to deter attacks upon themselves as well as improve identifications of suspects and transmit crime scene images. The U.S. Justice Department is looking into the possible transfer of this technology.

Meanwhile, the private sector has seen the market for security products and services and is wasting no time in seizing opportunities. The private sector would love to equip every home, office, and vehicle with security sensors that would send signals via the NII, perhaps tying people and their cars to global positioning or the new "personal-for-life" telephone numbers. But should this public safety service be vested in the

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private sector, and if so, will it be available only to people of means?

There has already been discussion and controversy surrounding the military's role in the war against drugs, to which must now be added law enforcement's concerns about its relation to the private security industry. What are the proper roles of these two entities vis-a-vis law enforcement in the new communications infrastructure?

Investments in Prevention versus Prosecution

Many believe that exploration of new electronic strategies to prevent and deter crime deserve equal or greater standing to ones for investigating and prosecuting crime. These may include experiments with new approaches for premises security, and will surely involve continued efforts towards controlling and monitoring offenders outside prisons. The development of "artificial intelligence" techniques to assist both crime solving and crime prevention might be enhanced by NII progress towards easy, inexpensive communication of multimedia information.

New strategies may extend even to state-of-the-art sensor-based projects, such as border monitoring to interdict smuggling, prison security systems, and advanced night and infrared vision systems for use by police officers. Such strategies can cost significant sums.

How much should governments invest in electronic and communications strategies for prevention and deterrence of crime, and how much in technologies for catching and prosecuting criminals, and removing them from society?

Reengineering Information Systems

Getting there seems also to include efforts to move the collection and processing of information into on-line computer-based systems. These projects can be very costly, and span many years. They include converting paper processes to electronic, adding image information to character data, entering into new information sharing agreements, and creating new databases. Among them are the fingerprint automation projects of the FBI and the various states, the development of DNA "fingerprint" data banks, new systems to implement the Brady Bill and other firearms initiatives, and projects to construct indices to facilitate information sharing among law enforcement agencies.

Which of these projects should have the highest priorities? How should the Federal Government's projects be dovetailed with those of the states? How should emerging technologies be woven into the project plans?

Fostering Communication with the Public

Communication between law enforcement agencies and the public they serve is a two-way proposition. Agencies could use NII capabilities to inform citizens, e.g., about wanted persons, missing persons, crime patterns, and special precautions. For its part, the public could use NII capabilities to request assistance, obtain information, provide tips and leads, and simply keep more abreast of what is happening in local communities on a day-to-day basis. Even now, the Internet is being used to send pictures and access policy bulletin boards. But, the Internet isn't a tool of choice for those who have the greatest interaction with public safety agencies.

What is the tool of choice for those most affected by crime? How many different avenues of communication should be pursued? How should cities differ from suburbs and from farms, parks, and forests? As the medium changes, how must the message change?

Security Overlay

Finally, getting there surely will involve the implementation of a security overlay to protect not only the line officers and private security who are on the public safety front lines, but also the personal privacy of the country's law-abiding inhabitants. The same extensive communications environment that can foster public safety can also be used by criminals to

thwart it. Officers and security personnel are paid to take risks, but the risks ought not come from their intercepted communications.

As information systems are re-engineered and new ones built, with more databases on more people about more subjects, accessed by thousands of criminal justice personnel nationwide, how can we ensure the highest levels of system integrity, data accuracy, and appropriate use? Which of these systems, if any, should be accessible to private sector security services, and under what terms and conditions?

Furthermore, security issues related to public safety extend into "white-collar" crime, where the concern is more about crimes against property. Estimates place electronic crime against the country's financial and commercial systems into the billions of dollars each year. Credit-card and bank-card thefts, "stolen" personal identification numbers, and related crimes ultimately hit every pocketbook. What do we need to do to minimize the risks and impacts of these offenses while utilizing NII infrastructure and related technologies?

(Note: The figures on costs of crime, sums spent, and numbers of agencies and personnel are from the National Institute of Justice, U.S. Department of Justice.)

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In addition to receiving printed copies of "The Information Infrastructure: Reaching Society's Goals—A Report of the Information Infrastructure Task Force Committee on Applications and Technology" from NTIS or GPO, the document is also available electronically from the following sources:

1). The Information Infrastructure Task Force (IITF) Gopher Server: gopher, telnet (login = gopher), or anonymous ftp to iitf.doc.gov. The document is located within the Speeches/Testimony/Documents category, documents/papers subcategory. Access is also available over the World Wide Web (WWW).

2). The IITF Bulletin Board: Dial by modem to 202-501-1920. Modem communication parameters should be set at no parity, 8 data bits, and one stop (N, 8, 1). Modem speeds up to 14,400 baud are supported.

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